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*Annual report of the secretary
of the Connecticut Board of ...*

Connecticut. State Board of Agriculture

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FROM

T. S. Gold.

State of Connecticut

THIRTY-SECOND ANNUAL REPORT

OF THE

SECRETARY

OF THE

Connecticut Board of Agriculture

1898

PRINTED BY ORDER OF THE LEGISLATURE

HARTFORD, CONN.

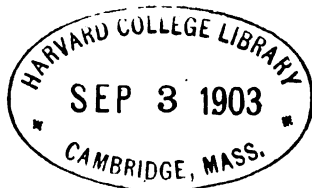
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1899

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(C. II. 74)



To the Governor of the State of Connecticut:

In accordance with the provisions of the Act creating a
STATE BOARD OF AGRICULTURE, I have the honor to present
the Report for 1898.

T. S. GOLD, *Secretary.*

WEST CORNWALL, December 1, 1898.

STATE BOARD OF AGRICULTURE.

1897-98.

HIS EXCELLENCY LORRIN A. COOKE *ex officio*.

APPOINTED BY THE GENERAL ASSEMBLY.

		Term Expires
Hartford County,	EDMUND HALLADAY, Suffield,	1901
New Haven County,	FRED'K DOOLITTLE, Cheshire,	1901
New London County,	E. JUDSON MINER, Bozrah,	1901
Fairfield County,	SEAMAN MEAD, Greenwich,	1901
Windham County,	MONBOE F. LATHAM, Phoenixville,	1899
Litchfield County,	EDWIN G. SEELEY, Roxbury,	1899
Middlesex County,	GEO. G. McLEAN, Portland,	1899
Tolland County,	CHAS. A. THOMPSON, Melrose,	1899

OFFICIAL LIST.

GOVERNOR LORRIN A. COOKE, *President*.

M. F. LATHAM,	Phoenixville,	<i>Vice-President</i>
T. S. GOLD,	West Cornwall,	<i>Secretary</i>
CHAS. A. THOMPSON,	Melrose,	<i>Treasurer</i>
Prof. S. W. JOHNSON,	New Haven,	<i>Chemist</i>
Prof. B. F. KOONS,	Storrs,	<i>Entomologist</i>
Dr. W. C. STURGIS,	New Haven,	<i>Botanist</i>
N. S. PLATT,	New Haven,	<i>Pomologist</i>

Auditors.

FRED. DOOLITTLE, SEAMAN MEAD, E. JUDSON MINER.

REPORT.

AGRICULTURAL FAIRS IN CONNECTICUT, 1898.

With Visiting Delegates.

- New London County, Sept. 5-7. Seaman Mead.
Windham County, Sept. 13-15. Geo. G. McLean.
Tolland County, Sept. 20-22. E. Halladay.
Berlin, Sept. 21. F. Doolittle.
Branford, Sept. 21.
Chester, Sept. 28. G. G. McLean.
Danbury, Oct. 3-8. E. Seeley and S. Mead.
Farmington Valley, Sept. 7-8. M. F. Latham.
Granby, Sept. 28-29.
Guilford, Sept. 28.
Harwinton, Oct. 4. E. Seeley.
New Milford, Sept. 6-8. F. Doolittle.
Newtown, Sept. 27-29. N. S. Platt.
Putnam Park and Fair Corp., Aug. 30-Sept. 1.
Simsbury, Oct. 5-6.
Southington, Sept. 27-28.
Stafford Springs, Oct. 4-6. Chas. A. Thompson.
Suffield, Sept. 21-22. E. J. Miner.
Union (Monroe, etc.), Sept. 21-22. S. Mead.
Union (Somers, etc.), Sept. 28. M. F. Latham.
Wallingford, Sept. 29-30. N. S. Platt.
Willimantic Fair Asso., Sept. 27-29. C. A. Thompson.
Woodstock, Sept. 19-21. E. J. Miner.
Wolcott, Oct. 12. E. Halladay.
Connecticut Hort. Soc.,* Hartford. T. S. Gold.
Connecticut Dairy Asso., Jan. 19-21. T. S. Gold.
Connecticut Pom. Socy., Wallingford, Oct. 13. N. S. Platt.

* April 5-7, June 22, 23, July 28, Sept. 21, 22, Nov. 8-10.

FARMERS' INSTITUTES.

In the season of 1898 Institutes were held in different parts of the State in accordance with the Prospectus given in the Report for 1897: Poquonock, Feb. 23d; Scotland, Feb. 25th; New Milford, March 2d; Southington, March 4th; North Haven, March 9th; Wapping, March 11th; Vernon Center, March 15th; Middletown, March 15th; Greenwich, March 16th; Norwich, March 22d; Danielson, March 23d; North Woodstock, March 29th; Tolland, April 2d.

The weather sometimes interfered with the attendance, but the speakers were promptly on hand, and the reports of the meetings were very satisfactory.

The Prospectus for 1898-9 provides for an increased number of speakers and wider range of subjects. That all parts of the State may be reached, and that all may enjoy the benefits offered, some local effort must be made. The State offers the advantages, they should meet a hearty acceptance.

PROSPECTUS.

Farmers' Institutes by the Connecticut State Board of Agriculture, in co-operation with the State and Storrs Experiment Stations, for 1898-99.

A committee representing the State and Storrs Agricultural Experiment Stations, and the Committee on Institutes, from the State Board of Agriculture, have formulated the following plan of Farmers' Institutes for the winter. It is hoped that Granges, Farmers' Clubs, and individuals will take an interest in this work and make early applications and arrangements for an Institute, so that the committee may be able to furnish the selected speakers. It is the wish of the committee to distribute the work as uniformly over the State as possible.

The plan is to hold at least two or three Institutes in each county before April 1st.

Management of the Institutes to be in control of a joint committee, consisting of a Committee on Institutes, from the State Board of Agriculture, and one member appointed by each Station.

The Board pays for printing and traveling expenses. The service of the speakers is rendered without cost.

It is expected that places applying for Institutes will furnish a suitable hall, local transportation for speakers and visitors, music if desired, and entertainment by collation or otherwise, unless there are convenient hotel accommodations.

When application for Institutes is made, four speakers and subjects may be selected from the list, and two of them may be expected to meet the call, but each one has the privilege of sending a substitute in case of disability from illness or otherwise.

Applications for Institutes should be made to the Secretary at an early date, giving post-office, name of railroad station, name of hall and distance from railroad station. Signify the day of the week preferred.

Attention to these details will save much delay in correspondence. As good speakers are offered, the responsibility of securing a good attendance must rest with each locality. Local lady speakers will be welcome at these Institutes. An exhibit of fruit and flowers is solicited.

The Question-box will be an important feature, allowing the introduction of any topic pertaining to agriculture.

A large choice of speakers and subjects is offered, but if we are obliged in some cases to send substitutes, we trust this will prove no disappointment. Some other speakers have been solicited, so that some may be sent as substitutes who are not on the list. Please bear in mind that our number of lady speakers is limited, and they must be excused from answering all calls if too numerous.

After a Grange or Farmer's Club has decided to apply for an Institute, a committee should be appointed with whom all the local arrangements should rest. The chairman of this committee must send to the Secretary, at least a month before the Institute is to be held, a list of names and addresses of fifty farmers living in the town, or towns adjoining, where the Institute is to be held, in order that personal letters of invitation may be sent. This committee should designate the place for holding the meeting, appoint one or two local speakers, provide music, arrange for transportation, collation, and otherwise enlist local interest.

LIST OF SPEAKERS AND SUBJECTS.

CONNECTICUT EXPERIMENT STATION.

Dr. E. H. JENKINS.

1. Farm Sanitation.
2. Tobacco: Fertilizers and Curing.
3. The Purchase and use of Fertilizers.
4. A German Agricultural Village. Illustrated by Stereopticon.

Prof. W. E. BRITTON.

1. Ornamental Planting of Home Grounds with Native Trees and Shrubs.
2. Spraying against Insects and Fungi.
3. Winter Gardening.
4. Our Insect Acquaintances.

Prof. A. L. WINTON.

1. Adulteration of Foods.
2. How Plants take their Food from the Soil, and what they do with it.

3. Ten-minute talks on Foods. Their source, process of manufacture. The homemade vs. the store products. Hints on securing pure Foods.
 - a. Flour and Cereal Products.
 - b. Coffee and Tea.
 - c. Butter, Lard, and Olive Oil.
 - d. Sugar, Molasses, Maple Sugar, and Honey.
 - e. Spices.
 - f. Jellies and Jams.
 - g. Canned Goods.

STORRS EXPERIMENT STATION.

Dr. W. O. ATWATER.

The Farmer and his Food.

Prof. C. S. PHELPS.

1. Feeds and Feeding of the Dairy Herd.
2. Home Mixing of Fertilizers.
3. Nature Studies for Rural Schools.
4. What can the Agricultural College do for our Young People.

STORRS COLLEGE.

Prof. A. G. GULLEY.

1. Weeds.
2. Arranging and Planting Home Grounds.
3. The Latest Concerning Spraying.
4. Our Insect Pests.

Prof. A. B. PEEBLES.

1. Climatology.
2. Twentieth Century Agriculture.
3. The Farmer's Environment.

Prof. L. P. CHAMBERLAIN.

1. Popular Fads in our Agricultural Practice.
2. What an Agricultural Fair ought to be.

Prof. N. S. MAYO.

1. Some Diseases of the Dairy Cow.
2. Wounds and their Treatment.
3. Examining Horses as to Soundness.
4. Germs and Germ Diseases of Animals.
5. The Kansas Cowboy.

Mrs. MAUDE K. WHEELER, Prof. of Domestic Science.

1. The Chemistry of Foods.
2. Hygienic and Dietetic Value of some Common Food Stuffs.
3. The Housewife's Invisible Enemies.
4. Proper Diet for Children and Youth.

Prof. HENRY A. BALLOU.

1. The Gypsy Moth: what it is, and what it does.
2. Insects Affecting Apples.

Mr. C. L. BEACH, Dairy Instructor.

1. Butter Making on the Farm.
 2. Improvement in the Dairy Herd. Types of Dairy Cows, with Illustrations.
-

F. H. STADTMUELLER, Secy. Conn. Dairy Asso., Elmwood.
The Cost of Production.

E. C. BIRGE, Southport.

1. Intensive Dairy Farming.
2. Home Manufacture of Farm Machinery.
3. Home-made Manure and Bought.
4. Fertilizers from the Practical Standpoint.
5. The Dairy Barn.

NELLIS H. SHERWOOD, Southport.

1. Weeds.
2. Growing Vegetables and Flowers.

H. G. MANCHESTER, West Winsted.

1. Good Potatoes and How.
2. Why our Farm doesn't Pay.

GEORGE H. MERWIN, Greenfield Hill.

1. Some things Agricultural Colleges fail to Teach.
2. From Calf to Cow.

THEO. A. STANLEY, New Britain.

1. Tile Draining. Does it pay?
2. An Important Element on the Farm: the Hired help.
3. The Use and Care of Tools on the Farm.

E. R. NEWELL, Plantsville.

Which of our Birds, if any, are detrimental to the Farmer?

GOOD ROADS: a necessity for farmers. How to make and keep them.

Through the courtesy of E. H. Wilkins, Esq., Portland, Conn., Chairman of the Highway Improvement Committee, Connecticut Division, L. A. W., we are permitted to offer lectures by different persons, well qualified to present this important subject. Some of these may be illustrated by stereopticon, and would require an evening lecture or a darkened hall.

The Audubon Society of Connecticut, through their President, Mrs. Mabel C. Wright of Fairfield, offers two lectures on Birds, fully illustrated by stereopticon. Early application, though desirable in all cases, is most important for all the illustrated lectures, as the slides may be engaged.

These lectures will be read, with the stereopticon to illustrate.

1. Facts about birds that concern the farmer.

Birds that protect the crops; also an account of the game birds to be seen in Connecticut during the year. Finely illustrated by pictures of birds of prey, insect-eating song birds, shore birds, and water fowls.

2. The birds about home.

An account of some familiar Connecticut birds, telling of their migrations, nesting habits, feeding methods, economic value, etc., and giving reasons, based upon sense, as well as sentiment, why they should be protected. Fully illustrated. (Suitable for mixed audiences of old or young people.)

N. B. — Please send in all applications early, that there may be ample time for arranging and advertising. It is

understood that individual lecturers, as well as the committee, hold the privilege of substitution when necessary.

COMMITTEE ON FARMERS' INSTITUTES.

CONNECTICUT BOARD OF AGRICULTURE.

T. S. GOLD, Secretary, West Cornwall.

E. G. SEELEY, Roxbury.

E. JUDSON MINER, Bozrah.

CONNECTICUT EXPERIMENT STATION.

Dr. E. H. JENKINS, Vice-Director, New Haven.

STORRS EXPERIMENT STATION.

Prof. C. S. PHELPS, Vice-Director, Storrs. •

FARMERS' CONVENTION AT HARTFORD.

The Annual Farmers' Convention was held at Hartford in accordance with the following program.

The reports of the Board, which largely consist of the lectures and discussions at these meetings, present the ripest thoughts of our practical cultivators and the most recent discoveries in science.

In the Farmers' Convention and Farmers' Institutes all matters pertaining to rural life have a place — the training and discipline of the body, mind, and heart, everything that tends to make the good citizen is favored, that not only individual success and happiness may be attained, but that every one may contribute their share in making this the happiest and noblest nation on earth.

FARMERS' CONVENTION.—Program of the meeting of the Connecticut Board of Agriculture, at Hartford, December 13, 14, and 15, 1898.

Board of Agriculture.—(Organized 1866, re-organized 1897.) Gov. Lorrin A. Cooke, President; Monroe F. Latham, Phoenixville, Vice-President; T. S. Gold, West Cornwall, Secretary; Charles A. Thompson, Melrose, Treasurer; Prof. S. W. Johnson, New Haven, Chemist; Dr. E. H. Jenkins, New Haven, Botanist; Prof. B. F. Koons, Storrs, Entomologist; N. S. Platt, Cheshire, Pomologist; Fred. Doolittle, Seaman Mead, E. Judson Miner, Auditors.

Members appointed by the General Assembly.—Edmund Halladay, Suffield, Hartford County; Frederick Doolittle, Cheshire, New Haven County; E. Judson Miner, Bozrah, New London County; Seaman Mead, Greenwich, Fairfield County; Monroe F. Latham, Phoenixville, Windham County; Edwin G. Seeley, Roxbury, Litchfield County; George G. McLean, Portland, Middlesex County; Charles A. Thompson, Melrose, Tolland County.

TUESDAY, DECEMBER 13.

10.30 A. M. PRAYER.

ADDRESS OF WELCOME, by the Mayor, Hon. Miles B. Preston.

INTRODUCTORY ADDRESS, by His Excellency, Lorrin A. Cooke.

- 11.30 A. M. LECTURE—The Present Attitude of European Science towards the Tuberculosis Problem, Dr. H. W. Conn, Middletown.
- 2.00 P. M. LECTURE—Education in Agriculture, and the Relation of our Public Schools thereto, Hon. George T. Powell, Ghent, N. Y.
- 8.00 P. M. LECTURE—The Growing and Curing of Wrapper Leaf Tobacco in New England, and elsewhere. Illustrated by stereopticon, Dr. E. H. Jenkins, New Haven.

WEDNESDAY, DECEMBER 14.

- 10.00 A. M. LECTURE—Meadows and Permanent Pastures, Col. James Wood, Mt. Kisco, N. Y.
- 2.00 P. M. LECTURE—Disposal of Garbage and Sewage in Town and country, Col. George E. Waring, Jr., New York.
- NOTE.—While this program was in the hands of the printer, news was received of the death of Col. Waring in New York, Oct. 29th. The hour for the lecture will be devoted to a memorial tribute to Col. Waring, by a number of his friends.
- 7.30 P. M. Common Sense Farming, Mr. R. S. Hinman, Oxford.
- 8.00 P. M. LECTURE—The Citizen's Duty to the Public Schools, Mrs. Alice Freeman Palmer, Cambridge, Mass.

THURSDAY, DECEMBER 15.

- 10.00 A. M. LECTURE—Fruit Culture. Orchards and Small Fruits, Hon. George T. Powell, Ghent, N. Y.
- 2.00 P. M. LECTURE—The Past, Present, and Future of Connecticut Fruit Culture, Mr. J. H. Hale, South Glastonbury.
- 7.30 P. M. LECTURE—The Value of Birds to the Commonwealth. Illustrated by specimens and by stereopticon, Mr. Frank M. Chapman, American Museum Natural History, New York.

After each lecture there will be an opportunity for questions and discussion; all interested are invited to be present and engage in the discussions. The ladies are especially invited.

Music at intervals in charge of Prof. A. B. Peebles.

A Question Box will be provided to receive questions upon any agricultural topic to be presented to the Convention for answer or discussion at convenient intervals.

The Convention will meet in Jewell Hall, Y. M. C. A. Building, corner Pearl and Ford streets.

An exhibition of Fruits, Grains, Nuts, and other Farm Products, will be held under the charge of Mr. N. S. Platt, Pomologist of the Board. **Ad-**

opportunity for testing fruits and exchanging scions will be offered, and specimens and scions of choice varieties are solicited.

Fruit-growers are especially invited to contribute fruits carefully labeled, fruit photographs, lithographs, casts, or models, implements used in culture, pruning or gathering of fruits, new or improved packages for shipment, and cultivators generally to bring or send collections of Corn and other agricultural products, Nuts, Syrup, Sugar, and Honey; Corn, three ears each variety tied in a bundle; samples of Butter and Cheese, both Farm and Creamery are especially solicited.

All articles for exhibition may be sent by express at the expense of the Board, to the Secretary at Hartford, to arrive on Monday, December 12th.

RAILROAD ARRANGEMENTS.

The N. Y., N. H. & Hartford Railroad will return, on certificate of the Secretary, at half rates over all their lines, those attending and paying full fare by tickets or mileage.

The P. R. & N. E. R. R. Co., will furnish certificates returning delegates at one-third regular rates, who have paid full fare going to the Convention.

HOTEL ACCOMMODATIONS.

The United States Hotel,	\$2.50 per day.
" Heublein, European plan, Rooms, without bath,	1.50 each.
" " " " with "	2.50 each.
" Hartford, American plan,	2.50 to 4.00
" " European "	1.00 to 3.50
New Dom,	2.00 to 2.50
Hotel Capitol, single,	1.50
" " double,	1.25
Farmington Avenue Hotel,	1.50 to 2.00
Hotel Brainard,	1.50 to 2.00
Sigourney House, double,	1.25
" " single,	1.50 to 2.00

Gov. LORRIN A. COOKE,	} <i>Committee of Arrangements.</i>
EDWIN G. SEELEY,	
T. S. GOLD, <i>Secretary,</i>	

WEST CORNWALL, Nov. 8, 1898.

REPORT OF THE PROCEEDINGS
OF THE
FARMERS' CONVENTION
Connecticut State Board of Agriculture,
HELD AT
Hartford, Conn., December 13, 14, 15, 1898.

Convention called to order at 10.30 A. M., by T. S. Gold, Secretary, his Excellency, Governor Lorrin A. Cooke, President, in the Chair.

Gov. COOKE. We will listen to a prayer, offered by the Rev. Dr. Lamson.

PRAYER.

Dr. LAMSON. Our God and Father, we confess Thee, Thy truth, Thy love, and the glory of Thy name. At the beginning of all undertakings worthy of men we should seek Thy favor; man should consult God. May we first of all turn our thoughts towards Thee, the source of all good, the source of all blessings, the source of all life. We thank Thee for the earth which Thou hast made, and for all the things that grow in it; for life, and for all those things which nourish life. We pray Thee that in all labor in the earth we may remember that the earth is Thy creation, and that Thou dost pronounce it now to be very good. May all that is done in these hours here and in these days be blessed by Thee. May our thoughts be attracted in such a way that we shall learn those things which lift us up, which elevate human condition, and draw all men together. Draw all men together as one in the nation, and as one in true devotion to the State. Draw all men to-

gether as one in the service of their King, and may we bow before Almighty God, and confess Thee our God and Father in the name of Jesus Christ, our Lord. AMEN.

Gov. COOKE. The next business upon our program is an address of welcome by His Honor, the Mayor of Hartford.

ADDRESS OF WELCOME.

Mayor PRESTON. Mr. President, and gentlemen of the Association: Some few days ago Mr. Gold honored me with an invitation to meet you at the time of your assembling in this city, and in response to that courtesy I am here this morning to extend to you in behalf of my fellow citizens of Hartford a cordial welcome. We are mindful of the vast advantages possessed by a city that is the center of a thrifty agricultural district, and whose farms and dairies are tilled and managed by intelligent, educated farmers, and we are glad to show our appreciation of your society, whose aims and objects, as we understand them, are for the discussion of those topics, and the promotion of all things appertaining to agriculture, that tend to be of benefit to agriculture, and the advancement of the interests of agriculturists. The interests of the farm are the interests of the city. It is said, and it has been well shown that the basis of all wealth, the primal basis of all business is the products of the earth, and hence all interests, urban, suburban, and rural are entwined and inseparable, and the business of the town feels with a sensitive touch the rise and fall occasioned by adverse or prosperous circumstances of the farm. These closing years of the century show great improvement in farm work, and when I look upon the conditions that prevail in the management of farms to-day, and contrast them with what were the methods that existed when I was a lad, I am surprised, to say the least. To-day, with the necessary implements for farming, for every operation from planting to harvesting, from sowing to threshing, and even the arduous, back-breaking labor connected with the raising of tobacco, and in the hayfield, all of that is now relegated to the past by the improved machinery, by the new methods now so largely used. And much of that machinery, too, invented by the lanky, taciturn, calculating Connecticut Yankee, who has made this commonwealth famous for its labor-saving machines, and the innumerable patents brought into being. It is stated

that the bleak and small farms of New England, with its adverse climate, which has been so aptly described by our fellow townsman, Mr. Samuel Clemens, or more familiarly known as "Mark Twain," as a climate with nine months winter, and three months very late in the fall, compelled the dwellers thereon to eke out a living by making some kickshaw or nicknack, some small or useful article whittled out with the knife, or made with crude machinery constructed by themselves, and then they sent out that missionary of intelligence to the rest of the country, the Yankee peddler, whose goods were called Yankee notions, and whose ability to bargain and versatility in trade caused envious competitors to spread the slander that his nutmegs were wooden and his oats were shoe-pegs. But success attended him, and to-day, we who are dwellers in the cities and manufacturing towns are conducting the great enterprises that are the results of these small beginnings. This city, to which I welcome you, stands among the foremost of our country in its insurance and financial institutions, for its great factories, and for the excellence of the products made therein, and not only in these, but in its educational buildings, and for its high schools and manual training schools; for its public buildings, and in that building on yonder hill in which you have a common stock with us, and a pride like ourselves. I would say about our municipality that we are at the front in all municipal improvements, with well-paved streets, the world-famous self-propelling fire engines, rapid transit unsurpassed by any city, and in all these things we are well to the front. We have large factories where our manufacturers are turning out machinery, and wheels, and horseless carriages, and many other things well known in the markets of the world. All of these things I am glad to call your attention to, and I trust that your labors here may be of benefit to you, and that you may have a pleasant time, and enough of your time remaining over so that you can see some of these things whereof I speak. Hartford bids you welcome. Our latchstrings are out to you, and I trust that you will have a pleasant and enjoyable time while you are here with us. [Applause.]

Sec. GOLD. The next speaker on our program is our honored Governor. We will now have an introductory address by His Excellency, Governor Lorrin A. Cooke, of the State of Connecticut.

INTRODUCTORY ADDRESS.

BY GOV. LORRIN A. COOKE.

Gov. COOKE. I wish, Mr. President and gentlemen, that I could speak as well as Mayor Preston has to you without any paper before me, but I confess that I cannot do it to-day. I will not detain you but a few moments, however, with my written talk.

All people should exalt the occupation for which they have been educated, and by which they obtain their livelihood. The cultivator of the soil, and the civil and mechanical engineer, as they study to overcome the obstacles which nature has placed in their way, but which can be made to yield to their far-sighted and forceful methods, naturally triumph in each new discovery or victory won. This pride in a calling is proper and stimulating, and necessary in order to achieve the best results in whatever we are engaged. A woman must delight herself in music, flowers, and in a well-managed house, or in dress, if she accomplishes much in those beautiful and necessary lines.

A Connecticut boy, born and reared to manhood on a farm, and all the time hating his occupation, and longing for an opportunity to engage in some other calling, should have his desire granted, because he will never attain to the best that he can do until he is in full harmony with his calling. The problem confronting those who wish well to Connecticut farming is, How can the bright, active young men who are born and grow to young manhood on a farm be retained there? The important fact is always stated whenever the question is mooted, that a farmer's life promises more of comfortable success than that of any other calling, but still it is lamentably true that the brightest and most promising of our farm boys, or perhaps I should say some of the brightest of our farm boys are constantly deserting rural homes for the village or city. Among some of the influences which, in recent years, have been at work in producing a more contented feeling among the young farmers of the State is that of the Grange, which I believe has wrought much good. And I might say right here that we have a good illustration in His Honor, the Mayor, of the way some of those boys who have left our country farms have turned out, and he is only one of thousands in Connecticut. It must be a stimulating thought to a young man to

leave a farm if he can become the mayor of a large and flourishing city like Hartford, but they don't all attain such a position. In addition to the Grange, one of the things which has produced a more contented feeling among the young farmers of the State is the introduction of labor-saving machinery, and thus the drudgery which a boy hates is, in a measure, eliminated from his life. If he now has the ability to guide and direct a good pair of horses, he may to-day do most all the work by machinery which those of a generation or two ago had to do by hard, laborious work. So that it seems to me that as the work becomes easier, and the drudgery disappears, really, to-day, with the prospect before young men I can see no excuse for deserting the good old Connecticut farms. Men of the mechanical and industrial occupations find it for their benefit to band themselves together in orders and brotherhoods, and I allude at this time to the introduction into the farmers' life of the Grange. This getting together in orders and brotherhoods, if accompanied by a careful observance of the principles of good citizenship, no doubt contributes to the welfare of all the members, and protects those classes against the greed and rapacity of those who in their hot chase after profits overlook, many times, the welfare of the men and women upon whose labor capital must always depend for any success. I personally know but little of the Grange, for the very obvious reason that I am not a member, but it is easy to see that any combination of farmers for social or business purposes must result in good to the calling if wisely conducted. One reason of the want of popularity in farming is the almost complete isolation of the families of the farmers. It often happens that the farmhouses are remote from each other, and in the loneliest part of the town, and under such circumstances the social qualities cannot be exercised or cultivated, and, as a consequence, the young farmers and maidens of the farms long for a different occupation. For this reason any organization which holds out concert of action, and the mingling of its members for social acquaintance, and the furtherance of mutual aims, should be encouraged. The discussion of public questions touching the farming interest is full of promise for the calling.

There is no subject in which the farmer is more deeply interested financially than that of taxation. In our rural towns the capital has steadily been withdrawn by the shrinking in

value of the farms, and many of these towns still carry the burden imposed by the civil war, and the maintenance of the same number of miles of highways and bridges, which never shrink, and the school expenses which can never be less, — all making taxation a serious burden to many a farmer whose income is not large. It is only a few years ago that these towns were annually called upon by the State for a certain percentage sum. The necessity for this State tax has ceased, and I trust forever. The present income of this State is sufficient, not only to meet all of its expenses, but if wise economy is adhered to it will satisfy half of the State indebtedness which becomes due in 1903. And why should a State continue on in indebtedness that can be paid without further revenue? Would a farmer who had a mortgage upon his farm be wise if he continued the same when he had the money to pay it off, and stop the interest drain? The State is paying over \$100,000 interest annually, and this should speedily be reduced. The farmers in the General Assembly, if acting in harmony on these questions of the wise and just expenditure of the public funds, as they did in a large measure in the last Legislature, can settle the policy of the State for a fairly liberal and economical spending of State money. The State Treasury, I am glad to say, is in better condition to-day than I think it has been for twenty-five years. But this fact, and let me emphasize it, should not be a reason for lavish appropriations.

Another influence for good to Connecticut farms, I think, exists in her agricultural college. There is a diversity of opinion in regard to the college, but I believe, to-day, any unbiased, candid man, visiting that institution would agree with what I have just stated. I always believed that there was the disadvantage of an unfortunate location, but notwithstanding that the college has gone steadily forward under many trials and adverse circumstances to its present promising and really prosperous condition. This has been wrought out by the hard work and self-denial of a band of intelligent, determined farmer trustees, and a fine corps of instructors. I wish every farmer in the State could visit the college and see for himself what has been done there, and is being done there, to uplift the agriculture of the State by educating nearly a hundred now of the sons and daughters of Connecticut farmers. I don't know but there are more than that. Some of these will no doubt continue on the farms and give new character

and dignity to their work, and to Connecticut agriculture in general.

One important branch of Connecticut Agriculture I cannot refrain from calling your attention to at this annual meeting. I refer to the State Cattle Commission. We easily can recall the disquiet and anxiety which prevailed among the dairymen and cattle-owners occasioned by the conscientious enforcement of the law of 1895, entitled "An Act concerning Diseases among Domestic Animals." Not alone were dairymen worried and discouraged, but milk consumers became alarmed, and in many cases refused indulgence in one of the most nourishing of foods. Under that law more than 1,200 cattle were slaughtered in Connecticut, with a total expense to the State of \$47,000. In 1897 the farmers in the General Assembly demanded, and when they demand they have their way, and obtained the repeal of the law, and the enactment of another in a very much modified form. The effect of this new law has been signally beneficial to the State. Administered by a wise and tactful commissioner, the alarm and discouragement have ceased, the use of milk much increased resulting in a saving to the State of more than \$30,000 annually, and all this without adding to the disease or the death rate of our people. The farmers of the State will no doubt insist upon the continuance of the present law until a greater need for some change is seen than is now apparent.

I believe that the present conditions of Connecticut agriculture are better than those existing during the past decade. The special branches engaged in by many farmers certainly are more profitable now than in past recent years. I refer especially to peach-growing, which was estimated in 1897 to be of a value of a million dollars to our State, and also to tobacco, which specialty is now profitable. The neglect of farmers to plant apple trees more generally in localities favorable to the culture of apples is lamentable. No better soil for the production of the best looking, and finest flavored apples exists in this broad country than the heavy soil of Litchfield and Tolland, and in portions of Windham and other counties in our State. When choice apples of well-known varieties, like the Northern Spy, Rhode Island Greening, and Baldwin, readily command the high prices that they do in our Connecticut markets it seems a great pity that our hillsides should not furnish apples enough for the State. Our farmers, I be-

lieve, are neglecting, among other things and other specialties, this one great thing of raising apples. They have not aroused themselves to the fact that Connecticut has over 900,000 people to-day, and when we were young, with not over half that number, and all the apple market we had was the cider mill, and a few barrels in the cellar for winter. To-day you go down Asylum Street, and you will see barrels and barrels that have come from the West, of apples not half as good as we can raise right here on our own hillsides.

One of our beautiful October days I went up to visit our agricultural college. I enjoyed the long ride from Willimantic on such a day, and under such circumstances as I was making it, as I had good company, two Congressmen, Henry and Simonds, so that we had good talk, and while I was pleased with the ride, I also observed the apple trees. The apples had not been gathered, and the crop was not promising. It looked scanty and of poor quality all the way up over the hills. We drove into the college grounds, and beheld every tree bending with a load of apples, beautiful in color, fair, and delightful to look at. I at once asked the reason for this wonderful display of fruit on the college grounds, and I had my answer right off. We sprayed those trees once, twice, and some of them three times, and we saved the apples as you see them. I believe there is a valuable lesson right there for our Connecticut farmers as regards the raising of apples. Yesterday, I was speaking to a neighbor of mine, a young man who was raised on a Litchfield County farm, a bright, intelligent man, and this matter of apple culture came up. I told him about this incident over at the school, and he says, "What is spraying?" He didn't know what it meant. I cannot but think to-day that you go through Connecticut and make a little investigation, and it will be found that a large per cent. of our farmers do not know what spraying is, as applied to apple trees. And it's because their attention has not been called to it. They do not read enough of the agricultural literature, for if they did they would have had their attention called to it. It is the salvation of our apple crop. Cultivating the trees and spraying them at the proper time saves them from insects which would otherwise prey upon the trees, eating them up, and destroying what is left of the fruit from being good for food.

Another example. You have all probably heard of the Manchesters of Litchfield County. They are good farmers.

Some of them were at the agricultural college. I had inquired far and near for a sample barrel of my favorite apples this fall, the Northern Spy. I could not find any. The farmers said they were not good this year. I called on my friend Manchester, who is up-to-date in most everything, and I asked him if he had any good Northern Spy apples. Yes, he said, come and see them. Well, I said, cull me out a barrel and bring them over. He did so, and of all the beauties of fruit contained in that barrel of apples! They would have delighted anybody's eyes. I never yet found a man or woman who didn't like a good apple. I said, "How did you get these apples? The farmers have all been telling me that there were no Northern Spy apples of good quality this year." "I sprayed my trees," he said. There it is. And the delights of fruit culture, to say nothing of its remuneration, are not half appreciated in our State. The Connecticut farmer has no one predominant crop like the wheat crop of the West, and consequently he must rely on the many specialities that stand waiting for him to take up. [Applause.]

Gov. COOKE. The next paper to which we are called upon to give our attention is "The Present Attitude of European Science Towards the Tuberculosis Problem," by Dr. H. W. Conn of Middletown.

THE PRESENT ATTITUDE OF EUROPEAN SCIENCE TOWARDS THE TUBERCULOSIS PROBLEM.

By DR. H. W. CONN, of Middletown.

Dr. CONN. Your Excellency, Ladies, and Gentlemen: I am very well aware of the difficulties that lie before me this morning in addressing a body of Connecticut farmers on a subject in which all are so interested and in which all have such very decided opinions. I am very well aware that possibly I may speak contrary to those opinions in some respects. Two years ago, when the subject was before the State Legislature, it was urged by the members of the Storrs Experiment Station that what was needed in Connecticut at that time was more information, rather than more legislation. The State Legislature did not see fit to appropriate any money towards obtaining such information, but the Storrs Experiment

Station has felt a decided interest in the subject, and as the result of the efforts of the Station, aided partly by the generosity of Wesleyan University, I have had the opportunity of spending the last year in Europe. I have spent that time particularly visiting various centers in Europe where the problem of tuberculosis is being considered and experimented upon and where the information that we have upon the subject is being collected. I think, therefore, that it may be valuable to bring to you this morning the general verdict of the present scientists towards the tuberculosis problem. I may say at the outset that what I have to report to you agrees very closely with the remarks of our speaker, and before I get through with my talk you will see why I have come to this conclusion. What I have to state represents in a large measure European conclusion. The facts apply to the United States in a little different way from what they do to Europe, yet the facts are the same. May I also make one more remark in introduction, viz.: I am intending so far as possible to bring to you the general verdict of European scientists upon this problem. But to determine a general opinion is not always possible where there are so many men of opposite views. It is rather hard to get an average opinion in regard to some of the points that I shall bring up. Therefore, in regard to some of these points, it will be necessary to use your own judgment, as I have done. May I also state that the lecture which I am giving this morning is but an abstract of a more full report, which will be printed in the annual report of the Storrs Experiment Station. The subject is a very large one to deal with in the time allotted to me. With these words of introduction may I now go directly to the subject. I shall divide it into two parts: First, the present condition of tuberculosis; and, second, the manner of dealing with tuberculosis.

It is not easy to determine the exact extent of bovine tuberculosis in Europe because of the uncertainty of the methods of obtaining statistics. The only accurate notion of the subject which is to be had is derived from the records kept in slaughter houses. Such statistics are, however, open to serious criticism. The amount of tuberculosis found in any slaughter house will be largely dependent upon the number of animals that an inspector is obliged to examine in a day, and also upon the care with which he makes his inspection.

Moreover, the desire of the inspector influences the results not a little; for one man, who is anxious to show that the amount of the disease is large, will hunt more carefully and find more cases than another man who desires to minimize the trouble or who may be simply careless. For these reasons it is practically impossible to compare the records obtained to-day with those made a few years ago, or to compare the records of different localities with each other. When the attempt is made to determine from such statistics whether the disease is on the increase the difficulties are still greater. Beyond doubt much more attention is paid to the matter to-day than a few years ago, and a much more careful search is made in the carcasses of slaughtered animals. The result of this would be an increase in tuberculosis, as shown by records, whether there were an actual increase or not.

For these reasons it is difficult to get any very accurate notion of the amount of tuberculosis at present. But in spite of these difficulties the statistical evidence has a very great significance. It is found that the amount of the disease in southern countries is decidedly less than in northern countries; that it is much less in countries where cattle are allowed to roam in the fields for a large amount of the time than it is in countries where they are kept housed for most of the year; it is found that within certain limits the amount of the disease is apparently greatest among herds which are given the greatest care. It is, therefore, more common among high-bred cattle than among common cattle, since the former receive the greater care. All of these facts are, of course, significant in enabling the farmer to know how to handle the disease. The amount of tuberculosis in southern Europe is rather small, but as we come to northern countries it increases, and finally, when we reach northern Germany and Denmark, the amount passes fifty per cent. When we compare the slaughter-house records from year to year, in order to determine whether the disease is on the increase, the result appears almost startling. In the city of Leipzig, where the most careful records have been kept for a number of years, the number of condemned cattle increased from 11 per cent. in 1889 to 33 per cent. in 1895, and has been rising since. In the most recent records of the city of Kiel, a city of north Germany, it has been found that 55 per cent. of the cows slaughtered in 1897 were tuberculous, and that of the animals im-

ported from Denmark no less than 66 per cent. were found to be affected with the disease. The significance of these figures is plain. In spite of all criticism to which the methods of obtaining the statistics may be subjected, we cannot hesitate to conclude that tuberculosis is rapidly increasing in Europe.

We turn now for a moment to ask how this disease becomes disseminated. There are three phases of this problem which must be considered: First, the dissemination from animal to animal; second, the dissemination from man to animal; and, third, the dissemination from animal to man.

Turning to the first topic, there is little doubt that the chief means by which the disease is distributed is from animal to animal. The farmer usually buys his tuberculosis in buying animals from other herds. When it once gets into a herd the methods of distribution are simple; since cattle drink from the same troughs, and eat from the same lot of hay, the bacilli which come from the lungs have a ready opportunity to pass from one to another. The common habit of licking each other is another means of distribution. The bacilli which are swallowed pass out, at least some of them, in the excrement, and may then be carried around the barn on the boots of the attendants, and easily get into the hay mow, from whence they may find their way into other individuals. When the animal coughs small particles of moisture are detached from the mouth and these particles may contain the bacilli and float around in the air for some time, to find their way eventually into the lungs of other animals. The chances of contamination from animal to animal in a herd are abundant enough. While there are some who think that other methods of dissemination are of more importance than this, it is certainly the decided opinion of the majority of scientists that the chief method of dissemination is from animal to animal.

The second question of the distribution from man to animal is one over which there is a wide difference of opinion. We find those who insist that this is the common, indeed, almost the only, method by which cows obtain the disease. They point to the common habit which consumptives have of spitting in the barn, and show how ready a means of infection this is for the cows. They tell us that the disease is sure to be found if the attendants are consumptive. They tell us that calves don't have tuberculosis when born, nor do they commonly acquire it while taking milk from their mothers,

even though the mother be tuberculous. They tell us that the calves only acquire the disease after they have come in contact with man, and the longer they live in daily contact with man the greater is the per cent. of the disease which is found.

Those facts are advanced as indicating that the disease may be carried from man to animals. But it seems to me that the evidence that we have on the other side is strong, and I think it is a fact that there is a general belief to-day that the disease is only in very rare instances transmitted from man to animals. In the first place there is no single instance known where the disease has been carried from man to a cow. Now this don't prove anything in itself, because even if such transmission did occur it would be a very difficult matter to prove.

But there are some very suggestive facts in this connection which have come out recently, and which throw strong light upon the point. I refer to the experiments carried on by Prof. Smith of Harvard University. He has been for some years convinced that the disease in cows and the disease in man do not have such intimate relation as was formerly thought, and within recent years he has experimented upon the subject. He obtained, for example, seven samples of tuberculosis bacilli from seven different sources, three of which were from cows who had the disease and four were from men who had the disease. The bacillus from man and animals is the same so far as could be told by the microscope or by any of the ordinary tests. It was the same in these seven specimens so far as could be told by the microscope. He kept the cultures under the same conditions, growing at the same temperature and in the same medium. The only difference between them was that four were derived from men and three from cows. Then he inoculated seven cows with the seven different kinds. What was the result? The three calves that were inoculated with the bacilli that came from cows all took tuberculosis of the severe type. The disease developed rapidly and in a short time they had a very marked case of tuberculosis. Of the four that were inoculated with the bacilli coming from man, three of them had a very mild attack, a slight inflammation around the place where the bacilli were inoculated, and a growth of a few tubercles in the vicinity. Then the disease stopped. They were only slightly affected, and then trouble

apparently stopped, and the animals appeared as well as ever. The fourth animal that was inoculated had no disease whatever. Now one swallow don't make a summer, but these experiments are extremely important. We find that the same general results are gradually being reached in Europe. Within a few months there has been published a paper in a German periodical in which the ground has been taken that there are a great many varieties of this tuberculosis bacilli, some of which are very violent in their action, some of which are very mild in their action, some of which are very much like those found in cattle, and others like the ones found in man. Now you will see the tendency of these facts. If they are true, it indicates that the disease found in man and in animals is not quite so closely related as we were inclined to think a few years ago. If it is true that the bacilli as it comes from man will not produce a severe case of the disease in animals, then, of course, the question as to whether man transmits the disease to animals is practically settled in the negative. If it is true that the bacilli that grow in man are only slightly pathogenic for the cow, it must follow that probably the disease does not pass from man to the cow to any considerable extent. While, as I stated a moment ago, there is no absolute consensus of opinion upon this subject, nevertheless I think I am not out of the way in stating that it is a growing belief that the disease is not transmitted very frequently from man to cows. It may be sometimes so transmitted, but rarely.

Now we come to the third of these topics, to wit: the distribution of the disease from a cow to man. Here, of course, you will see that the problem becomes extremely interesting, not only to you as farmers, but to the public in general. Is the disease ever transmitted from the animal to man? If so, is it common or is it rare? If it is distributed from the animal to man it must be apparently in one of three ways. Either by coughing the bacillus from the lungs of the animal and their being breathed into the lungs of the man, or by eating the flesh or drinking the milk of tuberculous animals. In regard to the first problem, viz.: the distribution of the disease through coughing or through some other actual contact with the cow, I may say again that there is absolutely no evidence of such a thing ever occurring, although again I say that the absence of evidence does not prove the negative.

It does prove that such transmission is certainly not common, but there is no conclusive evidence that it does not occur. So far as I know there are no scientists who think that method of distribution occurs except in rare instances.

Secondly, as to the question of flesh. Here is a question in regard to which there has been a decided change in opinion. There is no question but that the flesh of animals suffering from tuberculosis may contain tuberculous bacilli, and the question then arises if that flesh is used as food, can man take the disease from this tuberculous flesh? Now, there is no doubt that some animals, when fed upon this tuberculous flesh, have taken the disease. Numerous experiments have been tried, and the results were positive in many cases. There is no doubt that cats and guinea pigs, rabbits and dogs have all been given tuberculosis by feeding them with tuberculous flesh or other material from a tuberculous animal. The inference which has been drawn from this is that it is dangerous to use this tuberculous flesh for food. This was the opinion held for a long time, and this is the belief, of course, which lies at the basis of the methods pursued in our own State, to prevent the use as food of carcasses of all tuberculous animals. In this State if the animal is slaughtered and found to be tuberculous, the whole carcass is condemned and destroyed.

In the last few years in Europe the subject has been studied more carefully. In the first place, again, I may say that there is not a single instance known of man's obtaining tuberculosis in this way. It would be very difficult to find a case if it did occur. If a person has tuberculosis it is hardly possible to prove that he got it from eating tuberculous beef, even if that was actually the fact. We must remember, again, that meat is usually cooked before eating, and if it is cooked the tuberculosis bacillus is destroyed. If you heat your meat to a temperature of 160 degrees and maintain it at that temperature for some ten minutes there is no danger, no matter how much tuberculous material it had originally. Cooking thus reduces the danger very greatly.

Again, if a cow suffering from tuberculosis is slaughtered, it is only in very rare instances that there is any tuberculous bacilli in the muscles. The bacillus is commonly in the glands, in the viscera, in the lungs, but not in the muscles; and the fact that there is a tuberculous gland does not affect the muscles of the animal in the slightest degree. In an

animal with a very decided case of tuberculosis the muscles may be healthy, and just as good food as the muscles from an animal known to be healthy in all respects. Now, taking those things together there has been a decided change in the opinion as to the proper use of the flesh from tuberculous animals. I may say at this point that there is no place in Europe where scientists or veterinarians or meat inspectors would have the slightest thought of condemning carcasses simply because it was found that they had a few tuberculous glands. They have methods of treating this subject that we have not.

In the first place they commonly have meat inspected by government inspectors, and if these inspectors find a case in which the disease is scattered all through the body, they conclude that it had better be destroyed. Thus they condemn some whole carcasses which come under their inspection. But it is more common for them to condemn only certain parts. There may be a few glands in the viscera that are tuberculous, and these, of course, are destroyed, the muscle being freely sold. They have a further method of treating the matter. Some carcasses which are passed by the inspectors in spite of the presence of tuberculosis, are placed upon what is called the "free bank," in the market where it can be sold, but the public when buying it know that it is the meat of tuberculous animals. It is practically saying to the public, "We know that this is the flesh of tuberculous animals, but at the same time we do not feel it is bad enough to have it destroyed, and we will simply put it on this free bank so that you may know what you are buying, and so that you will know what you are going to eat; you must understand that you must cook it before it is eaten." Even such meat, if it is cooked, can be eaten with impunity. Now, all over Germany they have this method, whereby they can sell the flesh that is slightly suspicious, and the poor people are very glad to patronize this "free bank." They prefer the tuberculous flesh on account of its cheapness, and because they know if they cook it it is all right. Thus, a great deal of this tuberculous flesh that would otherwise be destroyed is eaten by the people and does no injury. The general opinion in Europe is that there is no need of condemning the entire carcass unless the tuberculous infection is very great. The method that has been adopted in this country

is that of destroying the carcasses of tuberculous animals in toto. This method of destroying the carcasses of tuberculous animals entirely simply because they are found to have tuberculosis is wasteful, and it is unnecessary. Such, at all events, is the universal opinion in Europe. Now, whether public opinion in this country will ever reach that point where we can adopt the European method is another question, and in regard to this I make no prediction. It is not necessary for me to discuss that feature of the question. But the scientific side of the question is very clear, and that is, that it is needless to condemn the flesh of all tuberculous animals, and such condemnation is an immense waste. There is no country in the world except the United States where it is done. All other countries will pass certain forms of tuberculosis where it is very limited, although they condemn others where the disease has affected the carcass to a considerable extent. We, alone, so far as I know — and I think I know the rules and methods in all countries — we alone, have adopted the rule of destroying in toto the flesh of all animals that has even the slightest suspicion of the disease.

Now let us turn to another feature of this subject, the question of milk. Milk, as a rule, in our country at least, is drunk raw. It is not cooked like meat, and, therefore, if it has any bacilli in it they are not destroyed by the cooking. Now I may state at the outset, there are only two countries I have visited where milk as a rule is used raw. Those countries are England and the United States. On the continent of Europe almost universally there has arisen in the last ten years the habit of boiling their milk. Thus the problem is very different on the continent of Europe from what it is in America. But even on the continent of Europe the problem has some similar features, because they do eat their butter raw, and butter is obtained from raw milk. If there were any bacilli in the original milk, they are extremely likely to be in the butter, and, therefore, the European nations are, so far as this is concerned, in the same position that we are.

Now what are the facts in regard to distribution of tuberculosis by milk. In the first place there is no question but that the milk of a tuberculous cow sometimes contains tuberculosis bacilli. They have been found with the microscope; they have been found by inoculating milk into other animals,

and producing the disease. Now the conditions under which the bacilli get into the milk are two. First, in a case of general tuberculosis, or where the disease has spread all through the animal, and secondly, in a case where the disease is located in the milk glands. If we find that the milk gland is itself tuberculous, and thus has the tubercle in it, or if the disease is general, being spread all through the animal, through the muscles and through the blood, we may find the bacilli in the milk. In most other cases we do not have the bacilli in the milk. Now you will see this reduces the danger very considerably, because the cases of general or udder tuberculosis are comparatively small in number. Under one per cent. of tuberculous cows have tuberculosis in the udder.

The evidence that we have that milk is the cause of the distribution of the disease is based largely upon experiments. Some of you know of these experiments. The milk of a tuberculous animal is sometimes fed to a guinea pig or more commonly inoculated into the abdomen of a guinea pig. Then the animal is watched for a few weeks to see if it develops tuberculosis. If it does the inference is that there were tuberculosis bacilli in milk, since it produces the disease in the guinea pig. The milk is dangerous for animals, and, therefore, it is dangerous for man, to drink. But we must question this conclusion a little. There is no question but that the milk of tuberculous animals will frequently give the guinea pigs tuberculosis, for this has been proved. But we should be a little chary of the positive conclusions which we draw from this set of facts. In the first place, a guinea pig is not a man. Furthermore, a guinea pig, as we know from experience, is extremely susceptible to tuberculosis, much more so, in fact, than is a man. And the fact that tuberculous milk will produce the disease in a guinea pig does not prove by any means that it will do the same thing in a man under the same conditions. Consequently, most of these experiments are inconclusive so far as this inference is concerned. It is a very different thing to inoculate milk into the abdomen of a guinea pig and have it produce tuberculosis from what it is when a man drinks milk. It does not prove that milk is dangerous to man simply because we find it is dangerous to this most susceptible animal. It does not do to conclude that because milk affects a guinea pig it will also affect man.

Another set of facts has within the last few months come

to light which throw a considerable discount over this whole series of guinea-pig experiments. In Berlin one experimenter found that the butter of the market contained tuberculosis bacillus, and that it was frequently present in as high as forty per cent. of the specimens that he experimented with. He claimed that he could produce tuberculosis in guinea pigs, and in some cases he actually found it in one hundred per cent. of the specimens that he examined. But a curious result has come from these experiments. It has been found that there is in milk and butter a second bacillus which looks like the tuberculosis bacillus. When it is treated with microscopical methods it cannot be distinguished from the tuberculosis bacillus, and when it is inoculated into a guinea pig, it kills the animal with a disease that looks like tuberculosis. But it is not tuberculosis. The tubercle it produces is something entirely different from the tubercle of tuberculosis. It is not the tuberculous bacillus. Now this, you see, throws a very great degree of discount over this series of guinea pig experiments. Don't conclude from this, however, that the real germ of tuberculosis is not in the milk, for it has certainly been found. We know now that the true germ of tuberculosis does occur in milk, and we know also that guinea pigs are given true tuberculosis by the use of milk. But these facts have also shown that many of the cases of disease and death in guinea pigs which are claimed to have been produced by tuberculosis bacilli from milk are, doubtless, due to this so-called false tuberculosis bacilli.

Another series of facts that has led to the belief that milk is the cause of tuberculosis in man has been obtained from the collection of actual instances where the disease has apparently been transmitted from the animal to man. I do not think there is any question that such instances occur. I will give you a single instance. There was a boarding school in Paris, containing fourteen girls. Nine of them were taken sick with tuberculosis, and several of them died. Of course there must have been some common cause of the disease in that school, and it was found shortly afterwards that those girls had been drinking the milk of one cow, and that the cow was very tuberculous. This fact, however, don't prove that the girls took the disease from that cow, but it renders it very probable. Now I simply give this as one instance, and there are quite a number of others. We have not found very many, but there are,

perhaps, a dozen of pretty well authenticated cases of the disease being transmitted from animals in this way to man. One of the most recent and the oddest one that I have come across, is this: There was a sailor that had his hand and arm tattooed, and in the tattooing milk was used. The milk was obtained from a tuberculous cow, and the man actually developed tuberculosis in the skin as the result of the tattooing. Of course the obvious inference was that the tuberculosis came from the milk.

Taking all these things together, we must reach this conclusion, that it is possible for the tuberculous disease to be carried from the cow to man through milk, and the question then arises, how great is the danger? Is it a rare occurrence, or a common occurrence? If it is a rare occurrence, is it so rare that it is something that we might very well neglect compared to the other sources of danger, or is it something that is really very serious? The only way to get at this question is to look a little into the statistics, and while it is a fact that you can make statistics prove anything on either side of a case, still it is worth while to pay some attention to this source of information. During the last forty years the amount of milk that has been consumed, either in the form of milk or butter, has been increasing, especially in United States and England, and to a less extent on the continent of Europe. During that time, too, as I have pointed out earlier, there has been, beyond any question, a very decided increase in the amount of tuberculosis in cattle. If, therefore, it were a fact that any considerable amount of human tuberculosis came from milk it must unavoidably be expected that there would be a corresponding increase in the amount of tuberculosis in man, and especially tuberculosis that might come from drinking milk. Furthermore, within the last ten years continental nations have adopted the habit of sterilizing their milk before drinking it. England and the United States still use it raw. If, then, it was a fact that any considerable amount of tuberculosis is due to drinking raw milk, it would seem that an increase should be seen in England and the United States, and that there should be a difference between the increase in England and the United States, and that seen upon the continent of Europe, where they have sterilized their milk.

What are the facts? In the last fifty years in Great Britain the amount has decreased thirty-nine per cent., and in

our own country the decrease has been equally great. I will not pretend to give the exact per cent. of reduction in our own country, but it has been, probably, about 40 per cent. On the continent of Europe there has been a similar decrease. During the last ten years the decrease in the amount of tuberculosis has been more rapid than before. The figures which represent the amount of tuberculosis have been going down for a number of years, and since '84 the disease has been decreasing more rapidly than ever. Now in '84 we first learned of tuberculosis as a bacterial disease and that the disease was contagious. Since then the amount of tuberculosis has been rapidly decreasing. The decrease has been just about as rapid in countries where they have been drinking their milk raw as in countries where it has been sterilized.

Putting all of these things together, what must we conclude in regard to the problem of transmission of tuberculosis of animals to man by means of milk? It seems to me that the conclusion that we must reach is this: There is danger in drinking milk raw, if that milk comes from a tuberculous cow, and especially if the tuberculosis is in the udder. The danger, however, has been in past years, doubtless, overrated, and, compared to the other dangers to which we are exposed, it is probably very slight. The statistics show that the great source of human tuberculosis is not from milk. It is probably from breathing the germs into our lungs from the air, but we are not increasing the danger very much by drinking a glass of milk that may have tuberculosis bacilli in it. At the same time we cannot deny that there is danger to man in drinking tuberculous milk. The extent of the danger no one can tell, although apparently it is slight. Furthermore, it seems to be pretty generally acknowledged in Europe that the danger is practically confined to infants. Children are more subject to this disease from drinking milk than adult persons. There is very little danger of an adult taking tuberculosis by the use of raw milk under ordinary circumstances. There may be danger in drinking milk from cows that are in an advanced stage of tuberculosis, or where the disease is in the udder, and especially so if one drinks a large amount of the milk. But in considering the extent of this danger we must remember that milk of the tuberculous cow in its distribution to buyers passes through a number of different changes; is frequently mixed with other milk, and by the time the consumer receives it it is pretty well

diluted. If it is sterilized all bacilli will be destroyed, and the danger removed. But even if it is not sterilized, the danger is so small, compared to the other numerous dangers to which we are exposed, that it may be almost neglected.

What must then be the conclusion from this part of my address? Simply this: The problem of tuberculosis is practically divided into two parts. One is a problem of human hygiene, the other a problem of agriculture. While they do have some relation to each other, they do not have that intimate relation to each other that our papers have told us they have in years past. One must be studied from the standpoint of human hygiene, and the other from the standpoint of agriculture. This problem of bovine tuberculosis is a problem for you farmers. This is the point I want to bring out as the important point of this part of the address. Bovine tuberculosis is an agricultural problem, and not so much as we thought a few years ago a problem of human hygiene.

Now, let us turn to the agricultural side of the subject. The second part of the address, as you will remember, was to be devoted to the methods which can be used against tuberculosis. As I have already indicated, the question as to how the disease is to be combatted is a question which interests you more than it interests the public at large. To what extent ought the question to be interesting to you? It is not wise to overrate the difficulties of this evil. But while it is not wise to overrate the seriousness of this tuberculosis problem to the farmers, it is equally unwise to shut our eyes to the actual condition of things. First, then, a word as to the seriousness of the tuberculosis problem to farmers; and in this statement I confine my remarks to the condition of things in Europe. If the disease is increasing at the rate I have indicated, you will see that it is becoming a very serious problem. In the country of Germany during one year there was an actual money loss to their farmers of a million and a half of dollars from the condemnation of tuberculous flesh. Now when you remember, as I have pointed out, that all the flesh of many tuberculous animals is sold, and only occasionally an animal condemned entirely, that when they are condemned they are usually condemned in part only, when you remember these facts, and learn, in spite of them, that there is still a money loss in one country of a million and a half of dollars yearly, you will see that it is certainly becoming a serious problem. Further-

more, when you add to the actual money loss the indirect loss, from the loss of milk, from the increased sterility of their cattle, from the increase of the suspicion of the public against milk, in view of the fact that the public knows that tuberculosis is becoming so common, when you remember also the fact that it is becoming more and more difficult to find healthy animals to breed from, you will see that the problem is becoming in Europe one the seriousness of which we don't quite appreciate. It is stated by agriculturists in their meetings that the time is coming, and at no great distance, when it is going to be simply *impossible for the farmer to find animals to breed from that have not tuberculosis*. They are extremely alarmed over the matter, very much more so than you farmers have ever been. They are talking of the matter whenever they get together and they repeat over and over again that *something must be done* or their dairy interests will be ruined. When you remember that in the country of Denmark, a leading dairy country of northern Europe, more than half the animals are tuberculous, you will, perhaps, understand more forcibly why they are asking themselves, in a state of considerable alarm, What can be done about it? How can this problem be met? Can the problem of tuberculosis in cattle be successfully attacked, and if it can be, by what method?

Some advances have been made in solving this question. The different nations have attempted to attack the problem in various ways, but as yet only provisionally. Each nation tries to protect itself against other nations, and that is about all they have done. Each nation makes a rule that they will not import any animals that are tuberculous, a rule that is very good as far as it goes, but it don't provide any way for getting rid of the disease inside of the borders of the State. There is, however, slowly appearing in the communities of Europe, a belief that a remedy has been found for this condition of things; that the problem is soluble, and that the solution is a matter which is in the hands of the farmers themselves if they will only use it. Now, it is extremely desirable that the farmers in our country should know what this method is. Some of you are familiar with it already, but it is too important to pass without consideration.

The first question arises as to how we are going to detect the presence of the disease. The starting point of any method of eradication is to determine the presence of tuberculosis in the

cow. The clinical symptoms for this purpose are of very little use, because they don't determine the disease early enough. They may detect it in the end, but the clinical symptoms do not act quick enough for serving the purpose which we have now in view. The only method that has been devised is one that you all know, the tuberculin test. Coming to this question, let me state the actual facts in regard to this tuberculin test. In the first place, as to its accuracy. The universal opinion in Europe, among all people who have used it enough to know anything about it, is that it is extremely accurate. Only in rare instances does it fail when it is used rightly. It may do so rarely, but it is a rare case indeed where an animal has been inoculated with tuberculin and presents no reaction, if the disease is present. Like anything else it must be used rightly, or it will give an improper result. It is the universal opinion in Europe among all people who have used it enough to know anything about it that it is almost absolutely accurate. There are some cases of advanced tuberculosis which do not react to it at all. Those cases, of course, do not need to be considered, because they will be distinguished by clinical symptoms. But among cases that are not advanced it detects practically all, and probably never picks out a case in which there is not some tuberculosis. It is, indeed, *too* accurate, as we shall see in a moment.

The second question in regard to tuberculin, as to its injurious effect upon the animal. It has been claimed that it has an injurious effect upon the cow. In my visits among people who know the most about the subject I have had long talks with the two scientists who have advanced this view and who have advocated it for years. They have given it up. All the other European scientists have given it up. These two men say: "While we still think that it may be that it sometimes produces a little increase in the disease, it is so very slight that it don't amount to anything, in view of the value of the test." Even the men who formerly advocated its evil effects, you see, are practically giving it up. On the other hand, in Denmark, they say they never have had a single instance of evil effect in all of the hundreds and thousands of inoculations.

The use of tuberculin has been abused. In France they have a law that no animal can be imported into the country until after it has been tested with tuberculin. Consequently,

in Switzerland, if a farmer suspects that he has an animal in his herd which has tuberculosis, he will have his whole herd inoculated with tuberculin, and then he will run over the border all animals that react. These animals recently inoculated are protected against a second reaction and pass for healthy cows. This is a very nice way of getting rid of tuberculous cows.

Tuberculin has, doubtless, been abused, but in those cases, which include the vast majority, where it has been properly used it has given good results. When improperly used the results have been, doubtless, unsatisfactory. In view of this fact I do not wonder that the farmers have been opposed to the use of tuberculin considering the many who have lost valuable cows by means of it. A cow is inoculated with tuberculin, it reacts, and the cow is slaughtered. An inspector works over that cow for one, two, or three hours, and finally finds some slight tubercle as evidence of tuberculosis, and he says: "That animal is tuberculous, and, of course, should have been slaughtered." I do not wonder that some of you are rather indignant. But don't you see it is not that the test is wrong, it is in the fact that you use the test for an improper purpose. It is not that that animal did not have tuberculosis, but that that animal ought not to have been slaughtered. In other words, where tuberculin has been used, as it has been very widely in this country, to condemn every animal to slaughter that reacts, a great mistake has been made. There is no country in Europe that would begin to think of such a thing. Up in Denmark they would have to slaughter half of their cattle. In the other countries in Europe they would have to slaughter from thirty to forty per cent. There is no northern country that would not have to kill at least thirty per cent. of its cattle, many of which, if treated properly, would recover. The test is too accurate. That is just the point; we have made a mistake, not in using the test, but in inferring that all reacting animals should be slaughtered. In Denmark they have watched this matter for years, and have found it to be the case that many of these tuberculous animals recover and subsequently live a good cow's life. It is not necessary to slaughter all, and here is the chief reason that has produced such a prejudice against having the tuberculin test. The farmers have objected to having it applied because if some of these cases were dis-

covered they may perhaps lose a lot of animals which are of value and which it is all right to keep. I do not wonder at it.

Now, then, we come to the special point. How are we going to treat the problem? The method that I now propose to speak of was developed in Denmark, and is now gradually spreading over Europe. It was first started some six years ago by Prof. Bang, in the Veterinary School of Denmark, at Copenhagen. I cannot here give you the method in all its details, but only its essence. It will appear later more fully in the report of the Storrs College Experiment Station. Its success depends upon the farmers themselves, and it must begin with them, and not with legislation. Here is one of the things which you must remember: Legislation cannot begin this process for you. The outline of the method is this: In Denmark a farmer who has a herd of cattle that is afflicted with tuberculosis must at the outset promise that he will strictly follow the rules that are laid out for him. If he will not do this, it is useless to do anything. It is one of those things where you cannot go half way and be successful. It is absolutely necessary to follow strictly the rules which are laid down in order to attain success. The farmer, then, must first promise that he will strictly follow the rules given to him. After he has done that all of his cattle are inoculated with tuberculin.

They are then separated into three groups, the first group containing those animals that have the disease in an advanced stage, as can be seen by the clinical symptoms. Those animals must be slaughtered. The second of the three groups contains the animals that do not react at all. The third of the group of animals are those that show no clinical or other symptoms, but react to tuberculin. These are presumably the slight cases. These last two groups of animals the farmer keeps, but he puts one in one barn and another in another. If he is unable to have two barns in which to keep the two separate groups, then he builds a partition between the two parts of his barn so that he can isolate the two herds. The essence of success is in this absolute isolation. He must not walk from one stall to another carrying excrement on his boots. He must not allow any employe having tuberculosis to go from one to the other and spit around the stalls. He must not allow the animals to go into the same yard, but must separate them in

different yards. In other words, he must have them completely isolated, or he cannot expect to attain a successful result. At the end of six months he inoculates again all the animals in his healthy herd. If any of these animals now react to the tuberculin test, he puts them with the reacting herd. He keeps this up, inoculating every six months, taking from his healthy herd all animals that react, and putting them with his reacting herd. In the meantime the calves which are born, either in the healthy herd or the other herd are brought up on sterilized milk, so that they cannot get the disease from their mothers, and then after they reach a certain age, they are inoculated with tuberculin. If they show any signs of reaction, they are put with the suspicious herd. Not unless they have been shown to be free from tuberculosis are they put with the healthy herd. In that way the farmer keeps two herds, one suspicious and one healthy, and he allows no animal to go into the healthy herd that has not been tested.

Prof. Bang thought that if he could keep that system up he would gradually be getting rid of the animals in the reacting herd until only the healthy herd remained. That process has been going on under his observation for six years, and the result has been this. In the particular barn where the experiment was started there were about two hundred cattle at the beginning of the experiment. When the first test was applied, of that number about one hundred and fifty reacted. This is certainly a large percentage, since there were only fifty healthy animals in the herd. They were separated, as explained, and they have been isolated ever since. He has been obliged to tear down the separating partition, and put it in a new place each year, in such a way as to make the space for the healthy herd larger. To-day the healthy herd contains over one hundred and fifty, and his reacting herd less than fifty animals. He has not got rid of the disease, but it is decreasing each year.

The beauty of the system is that it has been done without expense. Of course, there may have been some little additional expenses, but the plan, as a whole, is inexpensive, and the method is greatly to be commended for that reason. If a farmer has a large herd it simply necessitates different attendants to attend to the two herds, together with the expense of putting in additional partitions in the barn, but this is practically all the expense. This method has been widely adopted

in Denmark. The many farmers that have adopted the method are having the same results wherever they have followed the directions implicitly. Some have not followed the directions carefully, and, of course, where that has been the case, as would be expected, they have not obtained the best results. They let the same attendant walk from one stall to the other, or in some other respect do not take sufficient care in carrying out the details of the plan. The isolation must be complete and absolute. This method, I may say again, which was first advanced in Copenhagen, has spread from Denmark and is finding many advocates and followers even in southern Europe. Some of the countries in southern Europe are sending scientists to examine the methods as carried on in Denmark, and they are beginning to establish in other parts of Europe experiments to demonstrate to the farmers how they can actually handle the question on their own premises, and with very little expense.

The original inoculation of the animals ought to be made at the public expense. The State should furnish a veterinarian and the tuberculin, but the rest of the matter in which there is so little expense must be left with the farmer himself to carry out. Young farmers succeed better than old farmers, because the young farmers appreciate the necessity of complete isolation, whereas the old farmer thinks he knows all about it, and his success is not so complete. That is the case all through Denmark. Wherever they have got young men to take the matter up they have succeeded nearly every time.

Now I have taken more time than I ought, but I have not yet begun to cover the subject, and there are quite a number of other points about which I would like to talk to this audience. Perhaps I may now be pardoned if I say one word more. I want to repeat what I said at the outset. That this method of handling the subject must begin with the farmer. It cannot begin with legislation. There would be no use of passing a rule or making it a law that the method must be adopted, because if we did it would simply be a dead letter. The farmers themselves must start it *voluntarily*, and they cannot succeed unless they follow the directions implicitly and carefully. Therefore, there is no use whatever in beginning at the legislative end. If we want to master tuberculosis in our herds, we must begin at the farm end of

the problem. But there are some things that legislation ought to do. I think at all events it ought to prohibit men from selling milk coming from cows with tuberculous udders. Furthermore, I think that legislation ought to provide some means by which a farmer whose animal has been slaughtered because it shows upon an application of the tuberculin test a slight tuberculous condition, does not need to sacrifice the entire carcass. I think also legislation ought to be adopted which will encourage the adoption of these methods that are being extended in Europe for getting rid of the disease. Certainly, I think it ought to go as far as putting the tuberculin inoculation into the hands of State veterinarians, and making it free. But I don't propose to suggest any legislation except upon these three topics, about which I think no one would raise any question.

I have already taken more than my hour. I think it is the desire that whatever discussion there is upon this subject will come up later. Is not that the fact, Mr. Gold?

Q. Is it considered that the tuberculin test affects the milk of cows so tested?

Dr. CONN. Why, that claim is made. I think it is one of the questions regarding which there is a little difference of opinion; it is claimed that the flow of milk is temporarily decreased, and only temporarily. Not permanently, but only for a short time. I think that is the almost universal opinion.

Q. Well, isn't it claimed that it interrupts the flow of milk permanently also.

Dr. CONN. There is no reason for think that such is the case.

Sec. GOLD. We are obliged to adjourn the discussion upon this question until after the regular exercises of the afternoon. The lecture by Mr. Powell will come promptly as announced on the program, and after the discussion of Mr. Powell's lecture there will be an opportunity to hear further from Dr. Conn, and he will answer any questions, and you can keep it up as long as you please.

I wish to state also that the question-box is here upon the platform and invites your contributions. The questions will be attended to from time to time during the progress of the convention.

The exhibit of fruits is in the adjoining room, and other products, to which your attention is invited.

Gov. COOKE. The convention will now adjourn until two o'clock this afternoon.

AFTERNOON SESSION.

Tuesday, December 13th.

Convention called to order by Sec. Gold at 2.30 P. M.

Sec. GOLD. Mr. Seeley, a member of the Board, will have charge of the exercises this afternoon. Mr. Seeley of Roxbury.

Mr. Seeley assumes the chair.

Mr. SEELEY. Ten years ago it was my good fortune in traveling in the State of New York, looking over the interests of the milk industry there a little, to meet a man who seemed to understand what he was talking about pretty well in some of the different lines of work of interest to farmers, and it is that very gentleman that I have the pleasure of introducing to you this afternoon, the Hon. George T. Powell of Ghent, N. Y., who will speak to you upon "Education in Agriculture, and the Relation of our Public Schools Thereto."

EDUCATION IN AGRICULTURE, AND THE RELATION OF OUR PUBLIC SCHOOLS THERETO.

By HON. GEORGE T. POWELL, of Ghent, N. Y.

Mr. POWELL. Mr. President, Ladies, and Gentlemen: For a number of years we have been hearing the old, old story, farming does not pay. • Our daily papers have been filled with editorials touching upon the question of agricultural depression, and our magazines have been containing articles contributed by the sagest writers and thinkers of this country upon the cause of the agricultural depression. And so all our citizens have heard, and have for a number of years, about the

declining state of agriculture. Now there have been causes without any question of doubt for this condition of things. Every farmer and every fruit-grower in this meeting of the State Board of Connecticut is aware of the fact that the conditions in agriculture to-day are vastly different from what they were half a century ago, and every owner of land realizes the fact that there has been an exceedingly great depreciation in the value of land all over this great country. Every farmer realizes that the most difficult property on his hands to dispose of is farm property. We all understand that capital has been getting away from the land; that labor is going away from the land. We all understand that it is an acknowledged fact that the young people are going away from the land. Now, then, the question is, What are the underlying causes for this condition? I think that while we have been developing in every other direction through the agency of special preparation, while we have been developing our manufacturing interests through the agency of skilled men, and while we have been developing our railroads, and building up railroad interests through the management of exceedingly skillful and able men, we have not brought to our agriculture in recent years the same kind of training, and ability, and skill that has been brought to bear upon the other great industries of this country, and so we have at last got to that point where, in view of the conditions which we acknowledge exist, we have got to have the same training, and skill, and intelligence in agriculture that are brought to bear with such great results in other industries.

This afternoon I am interested especially in the discussion of the relation of our public schools to agriculture. Now I realize this fact, that the older men of to-day cannot possibly enter into the conditions that agriculture requires in these times, because they have not had the kind of training that is called for to-day. The same methods successfully followed by the farmer of fifty years ago, if adopted by his sons, will bankrupt them to-day. That is the reason why young men of our country to-day have not been as successful as their fathers were, because they have attempted in too many instances to follow in the footsteps of their fathers. The conditions are different, and hence they cannot possibly succeed by the use of the same methods by which their fathers were abundantly successful. So, while these conditions are ap-

parent, there is no criticism to be pronounced on the old farmers, because they were tilling the soil when it was rich with its virgin fertility, and it was only necessary for them to be fairly good cultivators, and put in the seed and take out sixty or a hundred fold. They had the advantage of a fertile soil that would respond to their efforts. To-day the conditions are vastly different. His Excellency, the Governor of your State, referred to the fact this morning, that the wealth of this country, primarily, has been taken from the soil. It is true that the vast wealth which has helped to make us the greatest nation of all the nations upon the earth has been taken from the soil, but it is another problem to-day that confronts our farmers if they would continue that taking of wealth. So that the young man who attempts to take up this line, and take still further wealth from the soil, has got to be a man of education and training, and right here comes the important question, How can we give these young men and young women this training? I believe we have got to start at the foundation. We have got to start right in our public schools. Now when we come to a proposition like this — to attempt to introduce a change in our educational system, it is a difficult thing to do. It is a very difficult thing to make these changes. It is an exceedingly difficult thing for the old farmers and old men in business to change their methods and system of doing business. It is a difficult thing for an educational system to be changed, and yet it is one of the things which is inevitable. It must be done. If we are ever to solve this question of the young men and young women leaving the farms, who ought not to, and there are some who certainly ought not to stay, because we do not want to hold all to the soil, but if we are to hold those who ought to stay then we want this special training that is given to young men who leave and take up other of the great interests of this country. We want that same training; we want equal training for the men and boys back upon these farms that will enable them to produce as far as possible the great results which special training has brought about in other lines. So that the system of education should be such that it will enable our young men who do from choice or necessity remain back upon the land to be successful. So this afternoon, I want as briefly as possible to present a practicable plan by which the teaching of the

principles of natural sciences applied to agriculture may be introduced into our public schools.

As your President has said, I have given years of thought and study to this question. It has been one of special interest to me. As I have seen the tendency on the part of so many of our young people to go away; to go to the cities and towns, which are overcrowded with population already, and which are to-day, for that very reason, confronted with some serious problems of government, and of a social and economical character, for that reason I have been interested in this subject, and in thinking out a plan which will make it possible for them to live, and successfully so, upon the land.

Now, then, let us take this question up practically, because there is no value in the discussion of any plan unless there can be some practical application made of it. We have an abundance of theories of education, but when it comes to a system of education which is thoroughly practical in its application it is not the easiest thing, always, to suggest. But still you are interested in the education of your own children, and I want, if possible, to give a brief outline of how to introduce the study, practically, of the natural sciences in our public schools.

We do not want any text-books upon this subject at the present time. I believe there is nothing that children revolt against so much as text-book work. I don't care what the subject is. You confine a child to a book and that child is the least interested in its work, and hence, I should say, in the beginning we do not want to flood our country with text-books in order to introduce the study of agriculture into our public schools. Now we want to teach the principles of natural science, and teach them practically from objects and from nature herself. We want to teach from nature, and not from a book. Now we have disposed of a great big problem when we get rid of text-books. The first question that is always asked by a teacher when discussing this question, is, Where can we get the books? I say to them, you want no books. Go to nature herself, and from the instruction and inspiration you get from nature teach that to the children. Now, the first thing I would say to you who are active in school work, or who are members of the school boards, encourage your teachers to bring to their schoolroom work first the objects that are all about them. This comes naturally right in the line of teach-

ing. Let them select the objects that are nearest by where the work of instruction is going on. First begin with the lowest forms of life. First, begin, possibly, with seeds.

Now I want to give you the outline of an exact experiment which I tried in a school of which I had charge; a country school of about one hundred children. I want to give you the outline of exactly the practical working of an experiment which was tried there at my suggestion. I made a collection of seeds representing the plants which grew in this district, taking, for instance, grass seeds. Every child is familiar with grasses. I brought seeds of timothy. I brought seeds of the red clover. I brought seeds of blue grass and of orchard grass, of the foxtail, and meadow fescue. Now, you go into a schoolroom and ask the children how many different kinds of grasses they can name. They will get, perhaps, two or three correctly. They will tell you timothy and clover. Beyond that you will not find one out of ten, yes, one out of fifty, that can name the grasses beyond timothy and red clover, and yet you can often go right out over our fields and meadows and find twenty-five different varieties in that same field. It shows how little knowledge there is even upon the part of those who live upon the soil of the vegetation that is growing under their feet. So I begin to study plant life right from the seed, and I bring to that room this collection representing plants of all kinds, — plants that grow in the meadows, plants that grow in the garden, and particularly food plants. Bring the seeds that represent those, and begin with the lessons right from the seeds themselves, and show what they will produce, and what they will do when they are placed in the ground. I remember an incident that occurred when taking up the subject of beans when I was assisting the teachers in my school district in conducting the first exercises as I had suggested to them to do. I had in my hand a half a dozen, showing different sizes and different colors, and called upon those children to tell me what they were, and what they would do; what kind of plants they would make, and what they would do, for instance, when put upon the teacher's desk. Some said "nothing." But, I said, when they are put in the ground what will they do? Well, there was a distinction between putting them in the ground and on the desk that some seemed to appreciate, and there was one little bit of a fellow about eight years of age, snapped his fingers, and he says, "I can tell you." Well,

I says, you are just the little chap we are after. Now tell me what you know about these seeds, and what they will do when they are put in the ground. And he went on to explain how he had seen beans planted in his father's garden at home, and in a few days they began to sprout. And there was the value of the thing coming out. There was a little fellow that had used his eyes, and he could tell what he had seen, and he went on to tell. He said in a few days he went back again, and then the beans had come up, and he said "the funny part of it was, after they got out of the ground they were upside down." The little fellow had been watching closely the process of germination of that seed, and he was a student not only of that particular process, but for the time being he was a teacher of the rest. So this would be one thing I would introduce into our public schools; the study of nature and of nature topics, drawing the illustrations and objects from the life of the school children receiving the instruction.

Now, to pursue this subject along this line just a little further, I would call for a description of the character of the roots of these plants. Now you see you are getting right into botany, yet nothing is said about botany, or the science of plant life, or the science of botany, but you have unconsciously in this manner led these children out in these country schools right into the study of botany, leaving out, of course, any attempt to classify, or anything of that kind, but teaching a few of the fundamental principles of the growth of plants, which is really botany itself.

Now, in the lesson upon grasses I chose this subject because these children came from a rural community, and I took the two seeds with which they were the most familiar, clover and timothy. I said to those children, Who can tell me the difference between the roots of the plants that will be formed from these two seeds, the timothy seed and the red clover? There was not one that could give a description. Now, see, how, in addition to the study of botany will come in an exercise in drawing. After the child has seen the form which the roots will take, I would send it to the blackboard to illustrate the impression it has upon its mind. So the description of the roots of the plant will be followed up by sketching. Now, for instance, take timothy. When that little seed germinates, the first process is to throw out fine, tiny rootlets along parallel with the soil. As it grows along, in the process of germina-

tion, it next throws down another system of roots a little deeper, and then still another system a little deeper still. And so in time this plant develops its root system, and you have this character of the timothy root, which farmers would do well to be familiar with.

(Mr. Powell illustrates his lecture by drawings upon a blackboard.)

Now what does that mean? It shows that this is a shallow land plant, and you have commenced to classify without realizing it. Shallow means a fibrous rooted plant, and so you get a distinction here by stating it in this manner without any effort on the part of the child's mind to remember terms, and the child has learned the substance of the thing it needs most without being taxed with technicalities or terms. Now, then, I would push on rapidly.

In the public schools most teachers find this to be a difficulty, the curriculum is so crowded with the common English branches that there is no time for anything else, they say, so where that difficulty exists I would devote but a few moments at a time to nature topics. But starting in this way I would push on rapidly with the illustrations. I would show the development of this plant. The foliage it puts out, and also the development of the seed life by which it reproduces itself again, and as we go along I would have the children go to the blackboard and illustrate as best they can the impression which has been made upon their minds. That is a kind of knowledge that I believe is valuable, and especially as to how the plant reproduces itself. We want the knowledge that it can be reproduced by hand, or by the rapid use of the hand in sketching. Now and then have a lesson on other plants. I can only give you a very brief illustration, and can only take one more under that line of plants. Now you take the seed of the red clover, a tiny little seed. Now what is the wondrous thing that is to come from that when it is put into the ground? Greater wonders than farmers have ever realized come from that little tiny seed. The same principle of development goes on at first, but when that seed begins its real work there begins an entirely different process. It begins to form rootlets, which go down into the soil, and instead of spreading out like the timothy, they go in an entirely different direction. The timothy throws out its system of roots as we have in this illustration, while the clover plant sends its roots down into

the soil, showing an entirely different habit of growth, and showing that this plant will stand dry weather. Now I have not the time to trace this out as I would like to do. But it seems to me that if we could have these principles taught in some such suggestive way to our children they would learn a lesson that would be of great importance to them when they come to leave the schoolroom and tackle a farm. I would dilate upon the difference in these roots. I would show that the clover is a deep-rooted plant. Its roots go down into the soil clear below the possibility of timothy roots, or of plants with that class of roots. That in itself is a thing which is exceedingly instructive to the children because it causes them to reason, and think from point to point. Every farmer knows that if he plows up timothy sward and plants the land with corn, or potatoes, or any kind of crop, he does not get the same result that he does if he follows clover with these crops. He invariably secures a good crop when he follows good strong clover sod, but perhaps he has not understood the philosophy of the thing. Now this would lead at this point, if any of the young people have evinced an interest in these exercises during the school week, directly into the study of agricultural chemistry. You see we just plunge into this whole subject of natural science in a perfectly natural way, and the public school is the place of all others in the world to teach these principles, and particularly our country schools. So that you see we come right into agricultural chemistry, and understanding fully the nature of these plants as we go.

Now, then, upon a critical study of this whole subject we will find when we come to make an examination of these plants more closely all up and down these roots are peculiar little bits of objects which the scientific man would call "nodules." Now these little knobs make all the difference in the world between those two plants. Here is one that leaves the soil better after it has been grown upon it than it was before, and here is one that leaves it in poorer condition. And so we study the character of these plants not only as to their root formations, but we study them with reference to their effect upon the soil, and in connection with that we take up the study of these nodules, and we find that there is a wonderful accumulation upon these roots. We find that these little nodules have a power and importance that is simply marvelous in its effect upon the soil, yet not one farmer in ten thousand ever heard

of such a thing when he was beginning. If he had only been told of the value of these little nodules when he was going to the little red schoolhouse it would have been worth thousands of dollars, and instead of leaving his farm in an impoverished condition; instead of leaving his farm so that his children cannot even afford to inherit it, as they cannot do very many farms, for it is an actual fact that the sons of many fathers to-day, in many instances throughout New England and New York, cannot even afford to inherit the farms, because, if they do, they are certain before long to have a mortgage upon them to raise money for living expenses, and they have been obliged to put it there because their fathers before them did not understand the value of these things which should have been taught them in their school days, and hence they went on making a fearful mistake in the management of their land.

Now this is the way in which I would introduce the study of plants in our public schools. Starting at the opening, and so carrying this subject through the entire curriculum of natural sciences, instruction without the aid of a single book through the entire term. This is not only delightful to the children, but it gives them information in a manner they will never forget. It brings a lot of instruction into the work of the public school when the boys and girls are capable of learning something of the soil, and what is in it, and enables them to learn something about the plants that grow upon it, and gives them some knowledge of these important principles which to-day the successful tiller of the soil must know about and understand.

Now I want to give one illustration of the value of this teaching. In 1895 I made a special investigation as to the condition of the farmers of New York State in relation to their soil, and in relation to their social and financial conditions. This was done at the instance of a body or committee of prominent citizens of New York. In 1895 there were 40,000 able-bodied men found going into the city of New York from the country, and it caused in the minds of some of our philanthropic citizens a feeling of alarm that such a great body of able-bodied men should go crowding into that great city, which was already overcrowded in its labor market, and so a special request was sent out to make an investigation into the conditions of the State, and for the purpose of ascertaining why

there should be this great emigration from the country to the city.

After having made this study, in view of a request which was made that some recommendations should be offered, which seemed the most difficult part of the problem, I made the discovery that 74 per cent. of all the answers received to this question, "Are the farmers inclined to leave their farms and go to the towns and cities?" came back in the affirmative; that there was a general inclination to leave the farms. In addition to that I found that the country schools of New York state were in a serious condition of decline. Many of the schoolhouses were closed, because there were not children enough remaining in the school districts to maintain schools. I also found in many sections of the state the churches closed, and in some places where a clergyman had one church originally he was carrying on three because of the financial condition of the residents of these localities, it being such that they could not support a minister for every church that stood upon the ground. This was serious. Now the recommendation that I made to remedy this condition was that we should introduce into our schools a course of study exactly upon the line that I have been outlining here; that is, the study of the natural sciences as applied to country life. The question was put to me, suppose this is introduced; will the children take any interest in this line of work? I answered that question practically by going through the schools of Westchester County where the experimental stage of this educational proposition was first inaugurated in this country. I made the proposition to every district school visitor, and every high school in that county, that to every child who would be interested in the study of a single plant I would send to that child one half dozen strawberry plants the following spring. I made that offer all over the county, not knowing, of course, whether I should hear from a single child the next spring.

During that winter I gave a course of lectures at the schools of this county on the subject of plant life, and on the subject of insect life, and animal life. Finally when it came spring I went back to my farm, and to my surprise as the warm, pleasant days of the spring came on, in came the letters asking for those strawberry plants. Each day my mail grew bigger. I soon found myself swamped with these orders for strawberry plants. I sent out everything I had on my own

farm, and then I sent out some of my neighbors'. But still the requests kept coming. I came pretty near sending over to Brother Hale to give me a lot of plants for these children, and if New York had not held out Brother Hale would have been called on also. There had been a real live interest aroused, and the proof of that was the fact that many of the applications came from the city children. The offer which was made in these country schools was published in the New York daily papers, and the city children read the papers and supposed that they were included, and so there came hundreds of letters from the children of the grammar schools of New York City saying they would be glad to receive these plants. Some of them said they had no garden, but they would find some boxes and plant the strawberry plants in the boxes, and put them up on the roofs of their houses or in the windows. Now that showed the interest, and the love which a child has for plants. I sent, I think, something over a thousand strawberry plants to New York City alone. Then the teachers began to apply. Teachers from Brooklyn, teachers from Buffalo, and from the other large cities of the state began to make application, saying that they would be glad to grow these plants in connection with their study of botany with their classes. Then the agricultural papers of the state copied the New York papers, and so the children of the district schools throughout the state began to apply as they supposed they were included, and soon I was literally swamped with these applications from all over the state. I never declined to send to any. I think I sent out something over fifteen thousand strawberry plants to the school children of my state. Now there was a practical illustration of the interest which was aroused the moment you spoke to a child upon the subject of plants. It showed the interest which children have in plant life. Now, with each one of these lots of plants a printed slip was sent out, and I want to give you all just a point or two on how the lesson of the strawberry was given to the children by the use of the chart.

Now, in presenting the question of the study of strawberry plants the interest of the child was at once, of course, reached through the plant itself, and so a correct illustration was given of the plant, and giving a description of its root system, and then how the plant multiplies--how it is propagated. I went right into the subject of the propagation of strawberries.

The question was put to the children in this way: you have got Sharpless, or some other variety down there, now how are you going to get another plant of that same kind? Why, it was a question they never had thought of. Some thought the plants came from seeds, and others said no, you get them from runners. So there were some children who had some idea of the propagation of varieties. The matter was explained in a very clear manner to them, and the principle of the plant itself was explained, that is, the principle of the study of the plant which it is understood controls that matter. If you want a number of varieties you must plant seeds, and you will get a great difference in variety, but if you want the same variety you must propagate it from this stem. Now, there are two of these upon these plants, one of which produces fruit, and the other produces plants. Those that produce plants will reach out their growth, and there develop a bud formation by which is reproduced exactly the same kind of variety.

At the World's Fair one of the most interesting of the New York State Horticultural exhibits was the strawberry plants in pots. Having charge of that exhibit I took special pains to have some very superior plants shown in pots, and we had them blooming and in fruit right through that wonderful exposition. One plant at one time showed 244 berries in process of formation. Thousands of foreign visitors, in looking over that exhibit, would stop and see that wonderful plant, and then they would take out their pencils and spread each one of these stalks until they had counted every berry that was in process of formation, or was formed upon that plant, and then made a memorandum of it to take it back to their foreign homes.

Now comes up the question, How was it possible to produce a plant that would produce such an enormous number of fruit-bearing stems? And right there is where instruction comes in of value by enabling us to understand the philosophy of the plant in order to control it, especially if one wishes to operate with this plant commercially. How much more successful would our strawberry-growers be if during the hours of their school days they could be taught some of these very important truths, and obtain a knowledge of plants like this, so as to know how to control them, so that if it is to be made a commercial matter they would know how to obtain the best

results. So the instruction goes along these practical lines, and we say to these children, if you want a plant yielding more fruit you must cut off its production in the direction of further plants; keep that continually in check, and then you develop its fruit-bearing ability. So the man who grew that plant for the World's Fair, understanding that principle, cultivated that plant from the time it began to throw out its runners, and by taking the proper course he developed another fruit-bearing stem, and that is how it was possible to produce such an enormous number upon that plant. Now that is valuable, and that kind of instruction is not only valuable, but interesting. It runs along purely scientific lines, yet with very valuable information in it. And that is my idea, farmers and friends, of teaching the natural sciences in the public schools. It is to teach scientific truths, and at the same time with a practical application that will be helpful to life and living.

Now, very briefly, let me take up the question of insects. I cannot delay longer upon the subject of plants. You can see from what has been said the wonderful field that opens up for teaching the principles of horticulture, and of agriculture in our public schools, and the opportunity which offers to turn our schoolrooms into a place of personal delight to thousands of children. Nor would I exclude it from the city schools. No place is more appropriate than in the city schools, where there are thousands and tens of thousands of children, especially in the large cities, that can never breathe a breath of fresh country air, or see the green of our rural communities. Of all places the city school is the place to teach these same principles to the end that there may come some conception in the minds of these city children of the beauty which exists outside of the great cities. So I would apply this line of teaching especially to the city schools in addition to our rural schools.

Now, upon the subject of insects. How would we approach the questions touching entomology. A great big, long word. I taught that to the higher grades, but to the little children never mention the term. Get at it in another way, that they can comprehend and understand. I would conduct the lesson in this way. I never shall forget an illustration that I made once to a body of school children in one of the cities of our State, where nearly 2,000 were gathered in the

great audience room of that school. I held up to the class two samples of apples. One had upon its side a big worm hole, and was so defective that it could be seen over a large portion of the room. I held up the apple so that they could see it. And then I held up a beautiful specimen, one that was fair, and clear, and beautiful in every respect, without a blemish on it, and I put this question to the children. I said, "Which of these two apples would you choose if you could have one of them?" Well, I should imagine if they looked at that sound apple their mouths would water, and they all said, "Why, we should choose the handsome, beautiful apple." "Why don't you choose this one?" I asked them. Well, some said it wasn't so good. Others said it had a big hole in it, and others said it was a wormy apple. That was what I was after. I wanted to call out the reason why they rejected that apple. Because it was a wormy apple. Then I said to them, "Now it is cut right in two, and I will hold it up so that all can see that that worm has traveled through the inside of the apple, and made the inside all undesirable. I didn't wonder the children rejected it. Everybody thinks so. That kind of an apple is a drug upon the market, and a curse to every fruit-grower. But you say, "Why can you sell it at all?" Simply because there are so many that don't understand what the matter with it is. They don't understand the history of the thing, and have no knowledge whatever how to prevent it. Why is such fruit put upon the market? Simply because many of our farmers and fruit-growers have no knowledge whatever of the cause, and hence the moth comes over our orchards doing damage untold in amount just for the want of knowledge of that one thing, the codling moth. And I explained it to them. Here it was. Here was its work.

As far as possible, I would have collections of insects to show to the children. Let the children go right out in the community and pick up the specimens, and when a subject like this is broached, go at once with the children through an examination of the insect itself, and you are pursuing a line of study that is of exceeding interest as well as of great practical value to them, but to illustrate the subject properly before a large class, it is easier sometimes to take a large illustration that all can see, and work from that. Now, here we have a large outline or representation of this moth that

does the damage to the apple. Now take up, for example, its life history, and pass it through a fifteen-minute exercise, so that every boy and girl in the school district can understand what this moth is, and the lesson should include an explanation of the remedy by which we can control it. I wouldn't simply teach the history of it, but I would teach a little science in regard to it, how to discover it, and how to control it. How to make a practical application of the knowledge imparted in regard to it. In the spring time as the blossoms begin to come out in our apple orchards, this beautiful little moth only three-fourths of an inch in length, when its wings are strong enough, begins to fly all over the country. As soon as the blossoms have dropped from our trees, then this little moth begins to lay eggs. It will lay them anywhere on the apple. We supposed a few years ago that they were always laid in a particular place. We now find out different. Our scientific men are all the time finding out something new, and so it has been ascertained that the egg is laid anywhere on the apple, but in a few days it hatches and finds its way into the apple and then makes very disastrous work in the apple. Now, when it enters the apple falls to the ground. It becomes a windfall. The wind will shake these apples off the trees. Then this little worm crawls out upon some loose bark upon the tree, or into some niche or space, and passes into its cocoon form, and is ready to come out again and repeat its life history when the blossoms come again. So you have here the life history of the codling moth in a period of fifteen minutes.

Now, then, as to the treatment. I would not leave the subject in this way, but I would say to these children, "When you go home to-night, you tell your parents how they can prevent this injury to their apples. I would tell the boys and girls to tell their parents "the apple trees are now in blossom. Look out for the codling moth, and as soon as you know it you get a pound of paris green, and you put it into 200 gallons of water, and then you get a force pump and spray all the trees thoroughly with this mixture. Now, then, to be explicit at this point so that the children of our rural public schools can go back again to our farms and make a practical application of their knowledge, I would tell them that when the apples are in this stage of their development they are always pointing upward. They are not as we see them in the fall. Your fruit-growers know that, but the children do not,

because their attention has not been called to it, but all these apples, at this time, stand with the blossom-end upwards, and, of course, when this spraying is thrown through and over these trees it naturally drops right in at that point. Now, it is right here that the eggs are hatched, and this little larvae operates, and if you examine these little blossom ends they will be found open, if the trees are sprayed at this time you get your poison right into that very point, but if it is delayed too long, and they close up, you are too late, and the spraying will be a failure. The trees must be sprayed before these close up. So many farmers say "Why, we have sprayed our trees, but we don't see any benefit." Nine times out of ten it is because they have sprayed them too late. It has closed up here, and the little worm gets in and begins to eat its way in, and the apple is injured. So you see the importance of applying the paris green mixture immediately after the blossoms have fallen, and so in giving these instructions the teacher wants to be careful and explicit upon this point.

Now, that is the way I would teach our children upon this question of insects, and I would take up as object lessons the insects which are working injury back upon our farms. And so, in the study of the strawberry plant; I would study that plant also in relation to the insects which attack it. The white grub, for example, which is so destructive to this plant. I would give the history of the white grub, and show just exactly how it does its work burrowing through the soil, and eating the plants right off close to the ground. And when the children are told that this June bug, which comes flying in through the open windows in early summer, and goes bumping against the lamps, and sides of the walls, is the progenitor of the white grub, they are astonished and surprised. They all know what a June bug is, but they have no conception that there is any connection between a June bug and the ruin of our strawberry plants. So the subject becomes one of great interest to them, and when they make the connection between that hard-backed beetle and the loss of that beautiful plant, they study insects with vastly more zeal and interest. And so I would go through the entire list of studies in this manner.

Now there is not time to pursue this subject further. I have only given, as briefly as possible, an outline of how to

teach these things in our schools. I believe the farmers ought to see that these things are taught to their children; the boys and girls out in the country districts, and if teaching and studying is carried on along these lines I believe we shall enter into a period of great prosperity in this country in agricultural development. We shall lift the whole subject to the position where our young people are craving for it, and that is, more of the intellectual in our farm life. I do not wonder that the boys and girls are going away from the farms to-day, when I consider how farming is conducted, with simply drudgery and hard work the experience of most all, and into which but a very little of thought, and study, and instruction enter. I do not wonder they go away from it. But taking up the subject in this manner in the schools, and then let it grow as it will, then as they go from the school back to the farm homes these little boys and girls will grow up with a knowledge of the soil, and with a knowledge of insect life and plant life that will turn to them in their after life many fold. And this would be the manner in which I would introduce it; just by incidental instruction in periods of from fifteen to twenty minutes each. First once a week, and then twice a week, and then possibly three times a week. Not changing the regular system at all, but simply substituting two or three times a week an exercise in the fields, or of this character, for some other exercise. Substitute an exercise in nature study. We can arrange this system for teaching agriculture in our public schools without disturbing or breaking into the working of our present system, and when our school boards and teachers understand that this can be introduced in this easy manner, and in this practical manner, then the objections and prejudice which always arise when a change of system is proposed will be quickly overcome. When this is done, farmers and friends, I believe we shall see new value in the depreciated farms of New England, and not until then shall we find that there will come to us buyers for land, because then it will have an enhanced value, and be attractive and keep at home the boys and girls who are now turning their faces towards the towns and great cities as places of permanent residence.

I shall be very glad to answer any questions upon this subject, and leave it now to you for discussion.

CHAIRMAN. I have no doubt that some of you would like to ask Mr. Powell a great many questions. Now, I will make this announcement: I understand that just such a talk as he has given us they want him to make up in New Hampshire, and he is going up there, and we want to give him a good warming up before he goes. I don't suppose you will be through with him, but he is coming back, and if you have got a lot of questions he is coming back to talk to us again, and after this splendid talk he has given us we will be all the more glad to hear him. Now, are there any questions you want to ask him? There is one thing certain; he has not gone beyond our reach. He has taken a little child and in some of the plainest and simplest and most practical terms shown us how it ought to be taught. You all knew about these things, but you had not thought of them in that way; that we could begin down with these little bugs and insects that eat up our crops and interest our children in that way. I believe he has given us one of the plainest and most practical lessons we shall receive at this convention. He has shown that our boys and girls have an appetite and craving for this very thing, which will be of such great benefit to them, and we do not give it to them. They have got a real healthy, hearty appetite for this thing, and we have not seen it. We have been giving them something that they had no taste or relish for. We give them an old-fashioned system of study that they tire of, and they worry, and they fret, and they steal away, and run away, anything to get rid of it. That is just the truth of it, and every one of you know it. There is not one of us but can take the lesson right home. Now have you any questions in regard to this matter?

MR. HALE. I would like to ask the speaker how he is going to get our school boards and teachers to introduce this into the school work? What are you going to do with them?

MR. POWELL. You have got to commence right in the nor-

mal schools. Start right there and train the teachers right in the normal schools. Then you get teachers who are fitted for the work. That is one of the difficult features. I never met a party of teachers in my life but said they were intensely interested in the subject, but they say "we never had any preparation for such work." There it is. Of course, I think it pertains to every teacher, and they should begin to study for themselves on these topics. But let it become a part of our normal school instruction. Let that be a part of the work of training teachers, and the rest is easy.

Mr. HALE. If they meet you with the reply that they have got a hundred other more important things on hand for the present, and they will, they will name over the new things that have been grafted on to our public school system of instruction, such as sanitary science, and all the rest — what are you going to do?

Mr. POWELL. Well, I think our system can be adjusted to it, and it will become a part of the regular work of the year. Now, in 1850, in France, it was optional, just as it is with us to-day, and it continued so for a number of years, until in 1879 France said the normal schools should teach these subjects. France required that the normal schools should prepare the teachers to teach these lines of natural science, and that it should be obligatory upon every school in France to have them taught there. That is the way it was done in France. It was made a part of the educational system, and that is where it should come in here in our own country.

I want to say that since the inauguration of this study in our own state the normal schools have taken it right up. It is not yet generally adopted, but at Oswego and Albany and Buffalo they are giving special training which will assure teachers along these lines, and it will not be long before it will be a regular part of the educational system of New York state.

The CHAIRMAN. Anything further on this subject? If

not, you know there is the matter that came before us this morning, the subject of tuberculosis, that, I have no doubt, you would like to ask questions about. Perhaps Dr. Conn would be willing to answer some questions.

I would like to ask the doctor one question. It is a very general question. He touched upon it, probably, this forenoon, but I didn't quite understand him; that is, what he would think is the most likely way for tuberculosis to be taken into the system?

Dr. CONN. You mean the human system or the animal system?

CHAIRMAN. The animal system, either human or dumb, rational or irrational, or both.

Dr. CONN. I am afraid in regard to that question it is a little difficult to give a categorical answer, because, at least, in the opinion of some people, the cause is not always the same. I think it is the almost universal opinion, however, that in the case of human beings it is, in almost all cases, taken in by breathing. I say almost all cases. There are many who hold the same view in regard to animals. They say that in the case of cattle the germs are almost always taken in by breathing. There are a few who hold that the germs are taken in by the food and drink that is swallowed into the stomach. I think it is the general opinion that in the vast majority of cases it is in-breathed, or it is the material which is taken into the mouth, and from the mouth passes into the lungs, and not, excepting in rare cases, is it the germs that pass into the stomach and intestines that produce the trouble.

CHAIRMAN. Another question I would like to ask Dr. Conn is, do farmers and dairymen in Europe give their cows exercise? Do they take special pains to give them exercise?

Dr. CONN. Very generally over there the cow is taken into the cow stable when it gets to be two or three years old, and it never goes out of its stall from that time until it is dead. That is a very common thing in many places in Europe. The

animals are kept housed from one year's end to the other, and never get any outdoor air. In the southern countries of Europe, such as Switzerland for example, which is the country that produces the most healthy cattle, that is not strictly the case. They attribute the health of their cattle there to the fact that during the early life of the cow in Switzerland she is kept out of doors nearly all the time. From the period when she is calved until she has grown up to the age of two years or more she does not go into the house at all. She stays out in the field, except, perhaps, in the very severest weather. Now, it is this that renders the Swiss cattle so hardy, and makes them not so subject to tuberculosis as cattle in the northern countries which are kept in the house during the most of their lives. Now in Holland the cattle go into the barn along about the first of November and stay in the barn until the first of May, or about there, and then from the first of May until the first of November they do not go in at all. They stay out in the field all the time. The farmer goes out and milks them in the field. Possibly, in this connection, it may not be inappropriate for me to emphasize a little more, a statement which I referred to this morning, and that is the value of outdoor life for cattle in preventing some of this disease which is so troublesome. It is certainly the case that it is very rare indeed for animals that live out of doors to have tuberculosis. Cases of that kind do occur some times, but they are extremely rare, and the amount of tuberculosis is directly proportioned to the amount of indoor life. I think that is something that our farmers ought to learn. And they ought to learn also that the method which has been quite generally adopted in our communities of shutting our cattle up in close warm stables, with too little air, and too little cold temperature, is the very best method that could be adopted to breed tuberculosis among cattle. We feel that we ought to keep our cows warm, but it is certainly the fact that cattle which live out of doors the most have the least tuberculosis. That is true of mankind also. You will

find if you look over the human race that the races that live out of doors, except in exceptional cases, those races do not have tuberculosis. It is the people who live in the house that have it. Now the reasons for that are many. In the first place, sunlight is the most powerful disinfectant known, and tuberculosis germs will die in a very few hours. That being the case, you will see that the chance of distributing, or taking the germs out of doors is minimized. That is one reason. Then another reason is, the lungs being the most common seat of the infection, it is perfectly clear, I think, to every one, that the lungs get into such a state that the little air cells do not get filled up. They sort of collapse altogether. They do not get a chance to be filled up, and cleansed with the pure air, and it is right into these little air cells that the bacteria get, and start to grow and become a tubercle. If, however, the animal is outdoors, and is breathing the pure air, that expands those cavities, or air cells, and helps to throw off the danger from these bacteria. It is not simply because the animal is out of doors, but it is partly because the animal is exercising in such a way as to make it breathe full and deep, and expand these little cells. How quick a man stops his exercise when it is severe enough to put him out of breath. Now you put a cow into a stall and keep her there, and she has no exercise, and hence these little air cells of her lungs go into a state of almost complete collapse if she is kept there long enough. Put your cows outdoors, and let them run over the fields, and let them get an airing occasionally, and their lungs will grow, and they will be a great deal more capable of warding off faint attacks of this disease, even if they have it.

MR. POWELL. I would like to ask if there is any difference in the type of tuberculosis bacilli in the human family? I know people who are intense sufferers from that form of disease in some instances, while in others it is not so bad. Is that accounted for by any difference in the type of bacilli?

DR. CONN. No, there is not. The microscope would not

show any difference, and the differences that you speak of are more local, due more to individual conditions in the man than in the germ. Of course, it makes a good deal of difference whether the bacilli affects the lungs, the kidneys, the glands — as, of course, where those different organs are affected it makes a considerable variety of forms of tuberculosis, but there are no facts that indicate that the different grades of suffering are due to any differences in the variety of the germs. I would not deny but that is the case, but the microscope shows no difference in the germs, and nothing is known in regard to that so far as I know.

I hope, in view of what I have said, that you farmers will not, perhaps, go to the other extreme. In the last three or four years there has been a very great excitement, and a good deal of agitation over the subject of tuberculosis, but you now know that that excitement and agitation is quieting down, and the talk which I have given gives you very good reasons why it should die down in some respects. But don't let that cause you to let up in the effort to protect yourselves against this disease. Let me warn you that it is equally dangerous and unwise to go to the other extreme. Remember the condition of things they have in Europe. We are here undergoing practically the same thing, except, perhaps, in degree. Over there they did not study the problem. They let it run on until they had tuberculosis to the extent of fifty per cent. Now it is almost certain that we are going to have the same experience here unless we take hold of the matter in time. You can readily see that the disease has increased, and it will not be many years before you will be brought face to face with the same problem that they have over there unless great care is taken. You must not go to the other extreme, or decrease your watchfulness. You must remember that it is a problem for you agriculturists to settle. It is one that you, as farmers, ought to settle, and one which you can settle, but the longer you wait the greater will be the difficulty in handling the

matter. I think that this morning I brought out the fact that the problem as affecting agriculturists and mankind is different. There are two different problems, but don't from that understand that there is any reason why you should say there is no such thing as this problem of tuberculosis in cattle, and that if it does not have such a serious effect upon mankind as was supposed, that, therefore, it is no longer a serious question. It is just as serious to the farming communities as it ever was, but it is not so serious for the public at large. I merely say this because I fear a wrong impression will cause harm, or that I was trying to smooth matters over and make it seem all nice. That is not the case. The problem is just as serious as it ever was.

Mr. YALE. I would like to ask the doctor if, from his present light, he would advise all dairymen to have their herds tested with tuberculin, and their stables partitioned off, as he has spoken of, and have two kinds of cattle, and two sets of men to care for them, and let them out every day in separate places, etc.? I would like to ask him if he would advise that, and, if so, how he would have our dairymen deal with this matter?

Dr. CONN. Of course, I recognize, as stated by this speaker, that this is not very practicable, but the exact practical application for every individual farmer, it seems to me, must be left to the farmer himself. I do not believe anyone here would have the hardihood to make any such sweeping advice as that. If a farmer has a small herd, and he has no reason for suspecting tuberculosis, I do not see, with my present light, why he should go to this trouble. If he has any reason, however, for suspecting that tuberculosis exists among his herd, then I should say, by all means, he ought to adopt this method. That is, if you have a large herd, where you are likely to have more tuberculosis, you want to keep it from spreading. When that is the case, then I should say, "try this method." But if it is a small herd, and you have no suspicions of the disease,

according to my present knowledge I do not think I would recommend its adoption. The actual method of making use of these facts must of necessity depend upon the individual circumstances of every individual farmer or dairyman. If I should fail to advise it I should run against some objection somewhere. I would simply say that it is a method by which a farmer can get rid of the disease after he finds out that his herd has got it. If he has not got it in his herd then there is no need of using this system, and that is a strong point which I did not touch upon this morning. If you have a herd which is now free from tuberculosis, how are you going to keep it out? It is comparatively easy, I think, and it only requires the application of three or four simple rules. The first is, you should allow no other animal to go into your herd until after you have proved to your own satisfaction that it has no tuberculosis. That is, do not buy any tuberculosis of your neighbor or dealer in cattle. Of course, that means young cattle, as well as old cattle. Don't allow any young calf to enter into your dairy herd until this calf has been tested. Again, don't allow strange cattle to associate with your herd, either in the fields or in your barn. Third, don't feed your calves with skim milk from the creameries which collect milk from all sources and mix it together. That is a very common practice. Milk is brought to a creamery from many different sources, run through the separator, and then mixed, and the skim milk is distributed. Now, if there is any tuberculosis in a dairy herd from which any of that milk comes it is going to be distributed. If you use that skim milk at all boil it. Another rule is, do not allow any consumptive patient either to attend your cattle or to prepare their food. If you will remember those four recommendations I do not think any farmer need to fear that he will have tuberculosis in his herd.

Prof. BREWER. It seems to me that of all the points brought out this morning, the one that we want to bear in mind most particularly in the treatment of this disease is that which

underlies the spread of the disease. The great remedy for preventing the spread of all diseases which can be taken by contagion is isolation. When it comes to all that class of diseases that mankind suffer from, science has everywhere found out that the best thing you can do is to isolate the patients. You take the cholera. The minute we find a patient who is suspected of having that dread disease we isolate the patient. You take the smallpox, and even though we have vaccination we isolate the patients, and in the case of some fevers, we isolate the patients. If you look over the records, where records are kept, as to how the various cases of these diseases are treated in order to prevent their spread, you will find that the great percentage is by isolation. Now, if I understand Prof. Conn, he simply introduces that principle into the treatment of this disease among cattle. Isolate the cattle. A farmer has got no choice in the matter. He has got one of two things to do. He has either got to suffer loss through the killing of his cattle, or else he has got to go to the expense of preventing his cattle that are well from taking the disease. He cannot go on permitting sick and well cattle to associate together without being a sufferer in some way pecuniarily. He has either got to go to the expense of preventing its spread or he has got to suffer loss if he does allow it to spread. It seems to me that it is a broad principle which is very plain. The farmers have simply got to take into account that isolation is what is most needed, and if our farmers take the view that they can better afford to suffer the loss of a cow than they can to suffer loss by prevention, then tuberculosis will go on unhindered.

Mr. ———. You spoke this morning, as I understood, that where an unhealthy animal was separated from the healthy ones, if the danger disappeared later on the unhealthy one could be moved over into the apartment with the healthy animals?

Dr. CONN. No. That is not the method. After an

animal has once been put into the unhealthy herd it is never put back even though it may improve. The idea is, in having a sick and healthy herd, to gradually eliminate those which show symptoms of the disease by the tuberculin test from the healthy animals, and to build up that herd by stock you know is free from the disease. An animal which has once been put into the reaction herd is never put back with the healthy animals again.

Mr. YALE. I want to ask the professor if we can check the progress of this disease by introducing plenty of openness and sunlight, if we suspect it among our herds, or must we go to the other extreme, and either suffer loss by separating the animals, which, of course, depreciates their value, or suffer loss by their death?

Dr. CONN. I think the universal answer to that question would be in the negative. If you once have the disease to any extent, while you might be able to check its progress in some animals you cannot do it in every animal, and unless you can do it in every animal you have still got it there. You can get less tuberculosis by such a course, but you cannot get rid of it all. As long as you have some animals that are still suffering with the disease every fresh animal that comes into the herd is liable to be attacked. So, while I say, in many cases, you can check the disease, and you can cure it in many animals, in all probability it cannot be done universally, and that method of dealing with the problem would probably be unsatisfactory.

Mr. IVES. I would like to ask the doctor if he knows of animals in advanced stages of the disease, — what is the result of that upon their product of milk and butter? What is the effect upon their capacity for production in the advanced stages of the disease?

Dr. CONN. Well, as to that, I simply know it is generally claimed that the animals do give less milk; that they have less appetite; that they are not so fertile; and, of course, in the later stages of the disease they become very emaciated.

Mr. IVES. Well, we hear so much of it, I suppose it has a bad result in the herd. That was the point I wanted to draw out. It curtails the amount of the production from the individual through this loss of appetite. Is that the result?

Dr. CONN. As the disease progresses it no doubt affects the productive power of the animal. A fatal result from tuberculosis is a very rare thing. A cow may have it and continue along for several years and still be profitable to keep. They live for a good while. There is no question but that probably the majority of the cases of tuberculosis would continue to live for years if allowed to, and continue to produce milk in fair quantity, and would be useful animals from the standpoint you refer to, provided, of course, that they are not allowed to injure their usefulness by giving tuberculosis to some other animals. Of course, if they are allowed to associate with other animals it is questionable whether they are useful. But if that is prevented probably a majority of the animals would continue to produce milk in normal quantities. The question is, what is to be done with the milk? That is not so easy for us to answer. If the animals are infected, what is to be done with their milk? If they are slaughtered, what is to be done with their flesh? In Europe they have solved that problem. The animals are slaughtered under government inspection, and if the disease is very bad the carcass is dumped, but if not, it is sold cheap, and everybody that buys it knows what they are getting. As to the milk, they say this milk comes from tuberculous animals, and should be sterilized before it is used. Of course, that solves the whole problem in Europe, but here, of course, a different problem is presented.

Mr. IVES. Are the germs destroyed in the process of condensing milk, or are they carried in condensed milk?

Dr. CONN. Not necessarily in the process of condensing milk, because the milk when undergoing that process is not heated to a temperature high enough to destroy them, but I

think there is no reason for believing that they could remain in condensed milk alive for any length of time, so that at the time condensed milk reaches the consumer I do not think there is any danger from that source.

CHAIRMAN. Doctor Conn has given us a great deal of information. Now, we farmers have to be pretty practical, and let us take just one suggestion. According to the statistics shown by Bulletin No. 41, issued by the Bureau of Agricultural Statistics in Washington, D. C., for the period covered by the ten years prior to 1880, and from 1880 to 1890, — I think I am correct as to the two periods, — we find that for the last ten years tuberculosis, or consumption, not in cows, but in people, has decreased forty per cent. I think Dr. Conn said thirty-nine per cent. Now, how has it been done? That is the question. It is people we are talking about, not cows. How has it been done? Has it been done by quarantining every consumptive patient, by taking them and shutting them up? Or, are consumptives privileged to move around among the population as they always have done? Why, it is the plainest thing in the world. Good sanitary rules and regulations, and knowledge relative to these matters have done it. Sunlight, exercise, diet, regular rules of living, and for building up the human system and making it strong. That is what has done it. Follow these rules, get plenty of sunlight and fresh air, good diet, and proper living, and disease will roll off like water off from a duck's back. Now I want you to go home and give your cows good water, good exercise, good air, and proper food, and in the name of mercy don't shut them up in your stables. If you do they will have tuberculosis. There is no herd of cattle that can be kept that way and be free from this scourge. I speak from experience. Twenty-five years ago they told me to close up the holes in my barn; every crack; every door. I did not think it wise then, but they told me it was. I tried it to my sorrow. I want my cattle every day, unless it is terribly cold and stormy,

to go out and exercise. I want the sun in the heavens to shine upon them. I want them to have pure water. I don't care whether I have one set of men, or two sets, but I want good, bright, active, healthy men, that know what they are about, and that know how to take care of my cattle well, and treat them kindly. Go home and treat your cows the same way, and just as sure as you are alive you will not have any tuberculosis if you do. I just give you this experience of mine as a farmer. Perhaps the chairman had not ought to talk so much, but I could not keep still.

Now, are there any further questions?

Dr. CONN. Apropos of the last remark, I would like to call the attention of the chairman to the fact that since we have learned the cause of tuberculosis, which was in 1884, we have adopted means for preventing its distribution, and preventing it in other ways, and this has caused a rapid decline. This is due not only to the things which you suggest, but also to sanitary means directed to particular methods and ways for preventing its spread.

CHAIRMAN. I meant to be understood in that way.

Sec. GOLD. Perhaps I may be pardoned for giving the history of tuberculosis on a small farm in this State that took place before the veterinarians and cattle-men knew much of what was going on. The man had about a dozen cattle, and took good care of them, but one would be taken sick, and linger along, and he would keep it three or four months, or perhaps six months, and then it was killed, or died. Within a year from the first one being taken sick, there was another taken sick very much in the same way, and after a time he became alarmed, as he was losing about one head out of the lot each year. He called upon our Cattle Commission, and we undertook to investigate the case, and we had it before us for several years, until it became so desperate and persistent that in some way it was closed up. I do not remember what was finally done. But I remember the man said then that if he

had taken the whole ten or a dozen to begin with and cleaned them out it would have been money in his pocket. He was keeping one or two animals that were poor, and valueless in their production, but which were preserving the germs of the disease and continued it in his herd. Now, we did not know much what was the matter. Tuberculosis was not admitted generally to be a contagious or infectious disease at that time. It was only faintly shadowed before us that possibly such was the nature of the disease. This was hard on to thirty years ago, when we were laboring in the realms of ignorance regarding it, and that was about the way it worked in that herd. That is about the way it works in most herds. If it was taking nine animals out of ten, and they were taken sick, and you should lose them within six months, why you would know something had to be done, but when there is only one that lingers along, and you do not know what the matter is, and then in the course of a year another one, you can see that it is a serious case. That was the case with that farmer, and you can see how discouraging this whole cattle industry was upon that farm. That is about the way that tuberculosis has of progressing on a farm. I have seen some cases, however, where it has spread more rapidly. Mr. Seeley has illustrated it by calling attention to tight barns. A man had built a barn that he thought was a model because it was so tight. All the lower part of it where the cattle were kept was lined with matched boards, and was just as tight as he could possibly make it, so as to keep it warm, and so there would be no freezing up where the cattle were. Windows were put in very close and tight, and they were designed to be opened for ventilation. He put his cattle in there, and it was discovered that there was some tuberculosis in the herd. After some months had elapsed they seemed to be growing worse. Quite a number of the animals seemed to be infected, and they were examined, and tested, and about half of the herd were slaughtered. Now, the air in that barn was the worst

air I was ever in in a cattle barn, or in any other place. My associates agreed with me, and when they got home their families thought so also, and expressed an opinion that they had been in some dreadful smelling place. There was no ventilation, practically, at all below. When they went into that barn they shut the doors. The cattle did not go out to drink. They were watered in the barn. I asked him, "How is it about your windows?" "Oh, well," he says, "when we got the cattle in here in the fall the windows swelled up so we have not been able to raise them up this winter. We did expect to raise them for ventilation." This was in the middle of winter, when the examination was taking place. The only ventilation was to let the impure air escape from the upper part of the barn, but there were no ventilators up there, and the rafters and shingles of the roof of that barn were all frosted over, and as it melted and froze there was no chance for the foul air to escape at all. That was the plan upon which that barn was built and conducted. Now, you can see what kind of a hotbed for the spread of the disease it was, and it was no wonder that in the course of five or six months there were but few of those cattle but were showing signs of tuberculosis, and were found to be affected and slaughtered. So that these actual facts that we discovered from our personal knowledge, running through a period of years, before we could get any material aid by arousing general interest upon the subject, shows what were the favorable conditions for the spread of the disease.

If there are no more questions to ask Doctor Conn I will try some of the questions in the "Question-box."

Here is one: "What is the best blackberry for market? And why are not our Connecticut people producing more of them?" I will call on Brother Hale to answer that.

MR. HALE. To answer the latter part of that question, first, there are so many wild blackberries grown in the State that the people pick and bring into market, and they are so

fine it tends to make the price pretty low. Cultivated blackberries are a little late, and there are some other reasons that interfere with their sale somewhat. The best one to sell is the Erie, because it's big and showy, but it's wofully sour. It's the best one to grow and sell, because the people in the cities don't know any better. Our native, wild berries are found in all our markets, and certainly in this section; our local markets in the central portion of the State are pretty generally overrun with native, wild berries at a very low price.

Sec. GOLD. You can pick them by the bushel up in Litchfield County. Here is another question: "Is it necessary to spray grape vines every year for either anthracnose or black rot?"

Sec. GOLD. I suppose that the grape rot has got to be attended to every year, or every time it comes, and it has to be attended to before it comes. That is the point. You must not wait until it comes. If you do, you can't get rid of it. You may protect the remaining grapes that have not been affected, but you can't cure it on the others. Mr. Powell explained to me to-day that he protected and saved half a crop of cherries by spraying with sulphate of copper twice a day for several days in succession just at the time when the rot had struck his cherries, and they kept spraying hour after hour, and they sometimes went over the same trees twice in a day. He says that they didn't cure any cherries that were struck with rot, but they saved all the rest. Now with grapes I suppose the same rule would follow. If you wait until they are struck with this black rot you would not be able to save those, but you might save the remainder.

Mr. ———. I would say in regard to the black rot that I have some vines that I keep cultivated, and on all those I have little trouble. They are very seldom affected, but I have others which are uncultivated around on stone walls and they are affected more or less every year. I think cultiva-

tion has a tendency to prevent it. Keep everything clear around the root, and away from the vine.

Prof. JENKINS. From what observation I have made in regard to spraying, where they are affected, or likely to be affected, it will pay to spray. It will often pay where they are not affected. There seems to be something in the spraying itself, even where the vines are not affected with the black rot, that is beneficial. For that reason we do not perfectly understand that spraying pays for itself, or nearly pays for itself in adding, or procuring an increased yield. Certainly, where black rot is present spraying will benefit the crop.

Senator LATHAM. I would like to inquire if it would not be advisable to both spray our apple trees in relation to the raising of apples, and also cut down a lot of our trees? For instance, we have a lot of unused land which produces a lot of worthless apples. They are good for nothing, except for cider, and some question whether it is advisable to make cider. But would it not be advisable to destroy those trees, as well as protect those on which we raise our fruit for market, and from which we pick our fruit for home consumption?

Sec. GOLD. My son would say that is sound doctrine. He has been advocating it for years, and has wanted to have me give him more free use of the axe than he has had yet, although I have already yielded to quite a degree to the operation. I have not gone as far, though, as he would like. He would like to make thorough work of it. The fact is, the young men are coming forward, but you can't get the old fellows always to accept these teachings. The young men are more susceptible and ready to adopt these new doctrines. That is just where we stand in our family on the question of neglected apple trees.

The CHAIRMAN. I think the Secretary has himself admitted that the boy knows more than the father.

Mr. IVES. Mr. President, sometimes there are memories.

associated with these trees, and we retain them for the sentiment there may be there, and not for the value of the fruit. I know a certain apple tree which was planted by my great-grandmother in her early life, and it still stands, and bears fruit, and, feeble and stricken as it is, why, I would not lose it for anything. Five generations or more have been sheltered beneath its branches and have eaten of its fruit.

Sec. GOLD. "Is it necessary to spray European Plums every year for the shot-hole fungus?" Dr. Jenkins, what has been your experience in regard to that?

Dr. JENKINS. I have not had any. I have not seen enough of it to insist that it was best to spray every year. On general principles I should say give growing fruit one spraying every year.

Sec. GOLD. "What is the greatest need in our apple orchards to make them more fruitful?"

Mr. HALE. Men who believe in them.

Sec. GOLD. Men who will act out their convictions.

Mr. HALE. Why, of course.

Sec. GOLD. "At what season should pruning be done, whether in the winter or in the early spring, on our farms?"

I think it is a fairly good season to prune in the winter, and it is the only season of the year that our farmers will attend to it with any degree of success. Now, in the matter of pruning apple trees, we must have a reasonable time in which to do it well. The work must not be hurried too much. Take time to look around and see what limbs are to be removed. The bark will not slip at that time of year, and you can get around in the trees without injuring the bark, and, on the whole, I prefer the mild weather of winter to do what pruning we have to do in our orchard. If you wait until later, as we are sometimes advised to do, there will always be something else that is pressing, and you do not do it thoroughly.

This question also wants to know, "What is the best

fertilizer?" I suppose that a good fertilizer with plenty of potash and some nitrogen is necessary for apple trees right along, and if it is not found in the droppings of cattle, and other fertilizers of the farm, why, it must be purchased. If you have got only a small quantity of orchard in proportion to the size of your farm you can probably furnish from your own home supply all the fertilizer that the apple orchard will need.

The CHAIRMAN. The Convention is now adjourned until 8 o'clock, for the commencement of the regular exercises, but at half-past seven Prof. Winton will speak on Food Adulteration.

EVENING SESSION.

Tuesday; December 13, 1898.

Convention called to order at 7.30 p. m., Mr. Seeley in the Chair.

Sec. GOLD. Prof. Winton will give you a little talk upon some of the products of the "Spice Islands," which he has here upon the platform, while you are getting ready for the other exercises of the evening.

Prof. WINTON. In the other room you have all, perhaps, seen our collection of foods, or the specimens of things which are used in the preparation of the foods which we eat. These samples, in part, have been exhibited before at meetings of the Board. At Willimantic we had a part of them, but since that meeting we have added to our collection considerably. In this case you will notice some of the common materials for adulterating food. You will see stearine, and cotton-seed oil, and other materials which are used in the preparation of lard, and in addition to cotton-seed oil there is olive-oil. Then you will notice glucose syrup, which is a sweet material put in molasses, honey, and maple syrup, and also various coffee adulterations. These I have here consist of Canada peas, wheat middlings, and artificial coffee made out of wheat middlings, and there are various other materials for adulterating coffee.

Then you will also notice cocoa shells, and buckwheat hulls, and other various products used extensively for mixing with ground spices. There is a long list of those products. Some of those in the other room have been prepared so that they can be used by the spice-grinders for mixing. Among the adulterated foods which we have found are vinegar and molasses, and among the foods which have been collected under our immediate supervision at New Haven are coffee, both whole and ground, lard, honey, maple syrup, various spices, cream of tartar, jelly, and so on. Time will not permit me to go into details with reference to these adulterations, and most of them have been discussed at other previous meetings; also at meetings of the Dairymen's Association. I will, however, call your attention to the jelly and jams. For anywhere from 20, 25, to 30 cents you can buy five pounds of so-called jelly, purporting to be made from strawberries, raspberries, currants, grapes, or, in fact, any fruit you want. For that amount of money you can buy five pounds of this kind of jelly with a nice pail, or earthenware jar or dish, which would sell at wholesale for fully five cents. Now these jellies cost only one-tenth as much as pure jellies can be made for in the household, and are various mixtures consisting either of a cheap, thin, apple jelly, or a starchy paste flavored with chemical flavors, colored with coal tar dye, sweetened with glucose syrups, and usually preserved with salicylic acid. The jams are somewhat similar, except that they generally contrive to put in some of the genuine fruit. I am told that at times, raspberry jelly has been made from various materials with hayseed added for the seed. We have not found this particular form of jam on the market, but probably will later.

Now a word with regard to the adulteration of spices. In the examination of food products the food chemist has been in the past very much hampered in his work, owing to the lack of knowledge as to the position of the pure article. Comparatively little has been done in the United States in the way

of examining food products for adulteration, so we lack the necessary data for our work. The Association of Official Agricultural Chemists, which has its representatives at all the stations, and agricultural colleges in the United States, has recently taken this matter into consideration, and through its members is making a systematic study of the various food products, and it seemed to us of Connecticut that we might very appropriately look into the matter of spices. We have collected a large number of samples which are being examined, and no doubt the actual results will prove of great aid, not only in adding to our knowledge upon the subject, but in benefiting the country at large. At other places they are carrying on investigations with other articles of food and we will use these results also. Some of these samples you saw in the other room, and I will call your attention particularly to only one or two of them. Now spices are extensively adulterated in this country, but the adulteration does not all begin here. The Chinaman has learned that the Melican people like cheap goods, so he has anticipated our wants. Here is a roll of China Cassia. Cassia is universally known as cinnamon. You would think to look at that specimen that it all came in fine, long pieces, but if you dig into it a little you will find it full of chips. A gentleman told me that he went up into one of the places where they make these goods, and he said that in front of the workmen were three piles: one of the long pieces of cassia, one of chips, and the third was ordinary street dirt. The workmen had to arrange these outside pieces so that the chips would be worked in, and, last of all, he would put in a liberal sprinkling of ordinary dirt. Now that is the material which our spice-grinders obtain and grind themselves and mix other things with it, so that the adulteration which is practiced in China is also carried on in this country until we are not at all certain of our spices. Of course, nutmegs are articles of small commercial value or importance, but they have always interested Connecticut people. Here

is a true nutmeg, and here is the sort which the Connecticut Yankee usually meets. Here is a longer one, a different variety, and inferior in quality to the round one. Now the grinders find that they cannot grind cloves, and some other things, to advantage, or so as to leave a good profit, so they grind up the leavings of the nutmegs that are sorted in eastern countries. I have here a box of these so-called nutmegs, but usually when we press them they go to pieces.

In the preparation of white pepper in eastern countries, in Sumatra, and various other places, they remove the outer shell and this so-called pepper shell makes a very nice material for mixing with bulk pepper, and it is very hard to detect. There is a great difference in the price of the elements which are mixed with our common pepper, so that you can see there is a wide difference in the quality, to say nothing of the adulteration that is practiced. The true cinnamon which I speak of is not on the market in the United States as a spice. A little of it is brought into the country, but the greater part of it is chiefly taken to South American countries. It is quite different from that which is ordinarily known in this country as cinnamon. Now I have called your attention to the way in which these samples are made up, and also to the fact of the forms of adulteration which we have found on the market, and for further particulars I will refer you to our publications, and also to the publications which will be issued in the future on this subject.

Sec. GOLD. How large a part of the ground ginger on the market is probably absolutely pure?

Prof. WINTON. I cannot give you the exact figures, but we examined quite a number of samples awhile ago, and I should judge that we found something like one-third of them adulterated. Taking spices all in all I should say, judging entirely from our work, that perhaps twenty-five per cent. of the ground spices were adulterated.

Now it may seem to some that our spices are articles of

relatively little commercial importance, but I have taken the pains to look up the figures a little concerning the spices that come into the country, and figuring roughly on the retail prices I have arrived at the conclusion that something like twenty million dollars worth are sold annually in the United States, and that Connecticut people spend something like \$200,000 a year for their spices. Now if twenty-five per cent. of these spices are adulterated, it would appear that you are spending \$50,000 every year for the adulterated article. Of course, that is only one class of adulteration. Coffee, lard, and many other things are very commonly adulterated.

The CHAIRMAN. I would like to ask the Professor if he thinks these adulterated spices are more healthful than the genuine, or not?

Prof. WINTON. This matter of the healthfulness of adulterated foods always comes up. Most of them are decidedly injurious to health. That is, acid adulterations, more particularly, are injurious to health. With regard to the use of preservatives such as salicylic acid, and boracic acid, sulphate of soda, and various other preservatives of this chemical nature which are used in food, they are pernicious to health. We can prove from the quantities used that they are all absolutely injurious to health. We think it devolves upon these people who use these substances for such purposes to prove first that they are harmless before they add them. Borax is also used for the preservation of sausages, and most of the tomato catsups are preserved with salicylic acid, and, as many of you know, it is also used in cider. Now these preservatives are used in small quantities, to be sure, but I do not think any of us care to use in our food articles which ought to be used only on a physician's prescription. Salicylic acid, you know, is an excellent rheumatism medicine. Now here is a dye which is commonly used in ink, and this one is used in red ink, yet either one of these articles would be injurious to health, and I am sure most of us do not care to try the experi-

ment. Plaster is used in cream of tartar sometimes, common land plaster. Now, of course, I cannot say that these articles will kill you in the long run. Plaster might if taken into the stomach in sufficient quantities, but our common sense tells us that we do not want to eat dirt, or plaster, or a lot of chemicals about which we do not know much of anything. It ought to devolve upon the manufacturers to state definitely just what the articles are which they offer for sale to the public containing such adulterants.

Mr. HALE. Would they sell them if they made that statement?

Prof. WINTON. They would not. Although they argue a great deal about their being entirely unnecessary, they do not add that they never have them in their products.

The CHAIRMAN. What is your remedy?

Prof. WINTON. The same old remedy which did not work in the case of tuberculosis — legislation. The people, as a rule, cannot detect these adulterations, and if the adulterated articles sell well the dealers will carry them. Chemists do not work for nothing, and in order to have their work thorough it is necessary for them to work under a State appropriation. I think if the public are thoroughly informed as to the character of adulterations the evil will be, in a measure, corrected. Perhaps later on it will be necessary to resort to some further measures.

Dr. JENKINS. I want to say just an additional word or two upon the work of the Station on this subject. It seems to me that for the present the law we have is a very wise one. Our experience in the matter of fertilizers has strengthened this impression. Now it is not possible for the State of Connecticut through the Experiment Station, to prosecute all fertilizer dealers who sell worthless goods, or for selling fertilizers which are guaranteed to be one thing, while actually being another, and, perhaps, poorer article; yet, at the same time, it is a fact that the publication of the regular analysis

of these goods which has been made at the Experiment Station has virtually driven out of our market many of the low-grade fertilizers which were a pest in this State. Now we have got a somewhat similar situation in the case of adulterated foods, and, as it seems to me, until we find out exactly the state of the market, and exactly what we want, and what we want to do, we have got legislation enough. We have not the power to do police work; we have not the power to prevent a man from selling cocoa shells as pepper, but we have the power to make an examination of what he sells under this name, and publish in our annual report exactly what we find. If we find that A, B, or C is selling pepper branded this or that, and which consists largely of cocoa shells we have the power to publish that fact. Now we have been working at the matter of spices for three years, and Mr. Winton tells me he has seen a considerable improvement in the matter of our spices. That is, they are not as much adulterated as they were. We believe if this sort of work is carried on thoroughly, with the publication it has, it will be enough to largely suppress, if not eradicate, the evil of food adulteration without further legislation. I think for the present we have legislation enough and what we have is working very satisfactorily.

The CHAIRMAN. It is time now for us to commence our regular program for this evening, and after we have had some music we will have the pleasure of listening to Dr. Jenkins of New Haven, on the growing and curing of wrapper leaf tobacco in New England.

[Music.]

THE GROWING AND CURING OF WRAPPER LEAF TOBACCO IN NEW ENGLAND AND ELSEWHERE.

BY DR. E. H. JENKINS.

Tobacco is an American plant. Of the eighty-two known species of *Nicotiana*, sixty-eight, at least, including those species which furnish the tobacco of commerce, are natives of this continent.

The use of tobacco, too, was at the first a distinctively American habit, at present regarded by a part of the community as a vice and by another part rather as one of the lesser virtues; like that other distinctively American virtue, total abstinence, which may be carried to such excess as to be a positive vice.

Wherever the first explorers of this continent met the aboriginal races, there they found practiced the smoking or chewing of tobacco.

In 1492 two sailors, sent by Columbus to explore Cuba, reported that the natives carried lighted firebrands with them, and blew smoke from their mouths and noses. This lighted firebrand was, doubtless, the aboriginal cigar, the wrapper being either tobacco or a palm leaf.

Oviedo gives us a picture of an aboriginal tobacco pipe, made of some pliable material, the forked ends of which, he says, were inserted in the nostrils, the other end put in the burning leaves, and the smoker inhaled the vapors till he was stupefied. This instrument they called "tabaco," which seems the most probable origin of the name since given to the plant.*

Lobel, in the appendix of his *History of Plants*, 1576, gives an illustration of tobacco smoking, as first seen by Columbus, at San Salvador, which is here shown in facsimile tracing. Probably considerable license has been taken with the original, as is true of sketches recently made in the same neighborhood by our war artists. He describes the pipe as a small funnel, made of palm leaf and filled with dry tobacco leaves, which are lighted and the smoke from them inhaled.

DeBry, in his *Narrative of Brazilian Travel*, published in

* It is not possible to reproduce here the pictures with which this lecture was illustrated.

1590, gives an illustration, evidently conventionalized, of pipe smoking in Brazil. The smoker is seated on a block, which looks quite too civilized to suit the rest of the engraving, while his wife, daughter, or sweetheart supplies him with the weed. De Candolle, however, says that in South America the natives did not smoke, but chewed or took snuff, except in Uruguay, Paraguay, and La Plata, where no tobacco was used; while in North America, from the Isthmus and the West Indies to Canada and California, smoking was universal and very ancient.

The early explorers say that the natives were able to withstand hunger and thirst for long periods, by the use of tobacco, the claims in this regard being the same that are made to-day, regarding the *Erythroxylon coca*, from which cocaine is prepared. The statements seem almost incredible, although smokers will agree that hunger, which can only be satisfied by food, may be considerably appeased by a pipe or cigar.

The next slide shows three pipes made by American Indians, which are figured in Breman's *Tobacologia*, published in 1626. They are, unquestionably, very ancient, though they might pass for modern pipes, so excellent is their finish.

A. is made from a stone of green color, commonly used, the author states, for cups and bowls, because the Indians ascribed to it the power of resisting poisons. Half of the anterior part is bound with a reddish bronze.

B. represents a pipe as long as a man's arm, therefore drawn on a smaller scale, of course, than the other. It is of wood, apparently turned as in a lathe, and bears beyond the bowl the carved image of an Ethiop. The bowl appears to have been smeared within and without with some form of black lead, to make it resist fire. The stem also bears a leaden band or ring.

C. is another form, quite like B. in its construction.

Among the aborigines tobacco was also used in religious and social ceremonials.

Monardes, a Spanish physician, in a work on the Properties of Herbs and Drugs, printed in 1574, says that the Indian priests in America, when consulted about the event of a war or other matter of importance, used to stupefy themselves with tobacco and, on their recovery, made answer according to the revelations of the trance. The same thing was done by individuals, without the intervention of the priest.

Without the priest and without the trance, the smoker of to-day will claim that, when excited or harassed, a quiet pipe or a cigar helps much to balance the judgment and clear the vision.

In these cases, the practice has a physiological explanation; but there are ancient Indian ceremonials connected with pipes and smoking which cannot thus be explained. Longfellow hints at them in *Hiawatha*. Gitche Manito, the mighty, calls to the warring braves:

"Bathe now in the stream before you,
Wash the war paint from your faces,
Wash the blood stains from your fingers,
Bury your war clubs and your weapons,
Break the red stones from this quarry,
Mould and make it into Peace Pipes,
Take the reeds that grow beside you,
Deck them with your brightest feathers,
Smoke the calumet together,
And as brothers live henceforward."

The red pipe-stone quarry was always neutral ground among warring Indian tribes.*

Miss Alice Fletcher, in a paper published by the Harvard Peabody Museum, gives a most interesting account of the ceremonies connected with the presentation of the pipes of fellowship among the Omahas at the present day, together with the music of the songs which are sung on such occasions.

The ceremonial pipes are made with secret ritual, ornamented with paint and feathers, every tint and article used being emblematic.

The ceremony, which lasts for four days, consists of the formal presentation of these pipes by a man of one gens to

* NOTE BY THE SECRETARY.—An incident in modern history that has just come to my knowledge shows that the "pipe of peace," with its soothing influences, is no ancient myth that has lost its powers, but still holds its sway to still the passions and harmonize the feelings of discordant humanity.

A conference was attended by a large number of legal gentlemen from all sections of the country to discuss and settle certain questions deemed by them of great importance.

The first day was spent in a general discussion, and a committee representing the different views of the members was appointed to prepare resolutions for the consideration of the convention.

So diverse had been the opinions supported by all the power of native eloquence enforced by local opinion and history, that, to a conservative man, the task of securing harmony of action seemed hopeless, and without it the convention would prove a failure. Prejudice or egotism will not yield to argument.

The committee met in the evening; a smoke was proposed, upon which all agreed there was a good, social time.

Our conservative friend ventured to make some suggestions, in a very modest way, about the matter in hand, which met with general approval by the harmonious crowd who had used their heavy artillery in the afternoon to show their sectional loyalty, and he was requested to put them in form.

These resolutions were approved by the committee, were reported to the convention, unanimously adopted by it, and it adjourned with harmony as complete as its opening had been tempestuous.

a man of another gens." "By means of this ceremony the two men become bound by a tie equal in strength and obligation to that between father and son."

The man who presents the pipes is called the one who sings; the man who receives them is called the one who is sung to, and songs form an important part of the ritual. A party journeying to perform the rite were never in fear of attack by the way, for war parties would turn to one side, letting the Pipes of Fellowship pass in peace.

On the next slide are shown the things used in this ceremonial, the cat skin, rattles for the dances, the tobacco pouch, and two ceremonial pipes profusely decorated. The stems are of a certain prescribed length and decorated in certain definite ways, but as these pipes are not used for smoking, the bowl itself is neglected, and may even, as here, be entirely wanting.

The next two or three slides show different parts of the ceremony, performed in the dim light of the wigwam or assembly hut. This is that part of the ceremonial which is called "Circling the lodge."

The next represents the preparation for the final dance, at the conclusion of the exercises.

The next and most striking of all is the "Ceremonial Rest."

Marquette, in 1662, writes that the calumet is "the most mysterious thing in the world. The scepters of our kings are not so much respected, for the Indians have such a reverence for it that one may call it the God of peace and war, and the arbiter of life and death. One, with this calumet, may venture among his enemies, and in the hottest battles they lay down their arms before this sacred pipe."

The Indian mound-builders of the western states, in pre-historic times, seem to have been inveterate smokers, and in shaping and ornamenting their pipes they showed great skill. Pipes are the most common articles of use found in the mounds. The general form of the pipe which may be regarded as the primitive one is shown in the picture. They were always cut in one piece, consisting of flat-curved base, the bowl rising on the convex side. Connecting with the bowl, through one end, is a hole about one-sixth inch in diameter, through which the smoke was drawn, with, apparently, no other stem than this, while the pipe was held by

the other end. This specimen is exquisitely carved from a beautiful variety of brown porphyry, granulated with variously colored materials. The stone is too hard to scratch with a knife blade, and how the Indians, without iron instruments, were able to fashion it is a mystery. The bowl is about an inch and a quarter high.

The other picture on the same slide shows a mound-builder's pipe, carved to represent a somewhat melancholy toad.

Whether the pipe was in use in the Eastern hemisphere for smoking some kinds of herbs before the discovery of America is a subject of dispute, but certainly smoke was used from time immemorial in the old world for producing exhilaration or inebriety, for medicinal purposes and in religious ceremonies.

Pomponius Mala says that wine was unknown to the Thracians, but that, as they sat about their fires at their feasts, they threw certain seeds (perhaps of Indian hemp) into the fires, which, being inhaled by the bystanders, caused the boisterous behavior of inebriates.

Alexander says the Scythians threw certain herbs into their fires and inhaled the smoke, which intoxicated them. Strabo says that these people also smoked pipes.

The Lybian Oracle, at Delphi, when delivering her utterances, sat over a sacred spot where a vapor rose from the earth. Perhaps it is a low, materialistic view to take of inspired prophecy, but it seems quite likely that prophecy required a stoker, who fed the subterranean fire with hemp or other intoxicant.

But, while smoke was used in these ways, there is no evidence that tobacco was used in other parts of the world, before the 16th century.

The Chinese, of course, claim that tobacco was used in the Celestial Empire long before the dawn of our civilization, but China claims prior use of everything, from the doctrines of the Sermon on the Mount down to gunpowder and playing cards. It is, perhaps, only poetic justice that now Russia and Germany, in the matter of unfounded claims, are paying China in her own old coin.

The accounts of the first introduction of tobacco into the old world are somewhat conflicting. A Spanish physician, Hernandez, is said to have first introduced tobacco into

Europe, in 1560, as a medicinal herb from the new world, and officers of the church and physicians were chiefly instrumental in calling attention to its merits.

Nicot, the French ambassador to the Portuguese court, bought some of the seed, said to have been gathered in Florida, and sent it to the Grand Prior of France. Nicot described it as an "herb of a peculiarly pleasant taste, good, medicinally, in fevers and other diseases." In France it was first known as the Herb of the Grand Prior, and, later, as the Queen's Herb, or the Medicinal Herb, while Nicot's name is preserved in the names of the alkaloid of tobacco, nicotine, and of the botanical genus, *Nicotiana*.

Italy received the weed at the hands of a cardinal, Prosper Santa Croce, and in his honor it was called the Herb of Santa Croce.

To Ralph Lane, John Hawkins, and Sir Walter Raleigh is severally credited the first introduction of tobacco into England, in 1586. Certain it is that Sir Walter was the first ostentatious smoker, who set the fashion and made the practice popular among the courtiers and nobles of London.

The habit was often called *drinking* tobacco, and it seems to have been a common practice to inhale the smoke and blow it through the nose, as is shown in this old cut from a Dutch book printed at Rotterdam in 1623, called "A Short Description of the Wonderful Plant, Tobacco." On the table are the trencher and knife for cutting the tobacco twist lying near, while the "drinker" exhales through his nose the smoke from the pipe.

After its first introduction, the use of tobacco spread through Europe and Asia with most wonderful rapidity. The reason for this is chiefly found in its supposed medicinal virtues. Botany, in its relations to medicine, was being industriously studied at the time. New "Simples" were being daily added to the *materia medica*.

Diseases of all sorts baffled medical skill, the rumors or the experience of great plagues terrified all men, and to test new remedies promised quicker relief than to study the causes of disease. Here was a new herb, brought from a far country. Taken into the stomach it was most potent; milder in their action were the fumes of the leaves. Many were the cures wrought by it, the herb being generally given with other

powerful drugs, and not unmixed with faith on the part of the patient.

"For," says a writer of the time, "it is a thing well known to all physicians that the apprehension and conceit of the patient hath, by wakening and uniting the vital spirits and so strengthening nature, a great power and virtue to cure divers diseases."

Says a chronicler in 1606 (Stevens & Liebault, "Country Farm"), "Nicotiana, though it have beene but a while knowne in France, yet it holdeth the first and principall place amongst Physicke herbs, by reason of his singular and almost divine vertues, such as you shall heare of hereafter, whereof . . . I am willing to lay open the whole historie," etc. Ulcers, cancers, ringworms, king's evil, and common wounds all yielded to the influence of the divine herb.

Later, it was stated that, during the great plague in London, tobaccoists and inveterate smokers escaped the disease, and the use of tobacco was recommended by the medical faculty and commonly taken as a preventative.

First introduced as a medicine, it almost immediately came into common use as an article of luxury, a sedative and a narcotic. Soon followed the abuse of it; first by the smoker and then, in the other direction, by the moralist. It so incensed that "most high and mighty Prince, James, by the Grace of God King of Great Britain," "Defender of the Faith," et cetera, that he issued his famous "Counter-blaste to Tobacco," a State paper which has contributed very much to the gaiety of nations, and is not really eclipsed, even by the speeches of William II of Germany, and his brother Henry, when the latter sailed for China. The three together are fine specimens of intellectual hiccoughs in high places. Of smoking, the Defender of the Faith said:

"It is a custom loathsome to the eye, harmful to the braine, dangerous to the lungs, and in the black, stinking fume thereof nearest resembling the horrible Stygian smoke of the pit that is bottomless." "It is like hell in the very substance of it, for it is a stinking, loathsome thing, and so is hell."

From this it would appear that the Defender of the Faith must have been indulging in Wheeling stogies, which answer perfectly to this picturesque description.

In Ben Jonson's "Every Man in His Humor," Bobadil exclaims: "By Hercules! I do hold it and will affirm it, be-

fore any prince in Europe, to be the most sovereign and precious weed that ever the earth tendered to the use of man."

"By Gad's me!" rejoins Cob, "I mar'l what pleasure or felicity they have in taking the roguish tobacco! It is good for nothing, but to choke a man and fill him full of smoke and embers."

Pope Urban the VIIIth, in 1642, issued a bill against the use of tobacco by the priests within the walls of churches, and especially while celebrating mass, threatening offenders with excommunication.

In 1650, Innocent X issued another bull of the same kind, which was affirmed by his successors, and remained in force till, in 1724, Benedict XIIIth, himself a great snuff-taker, revoked the edict.

It is stated that, in San Jago, in 1692, five monks were walled up for smoking cigars while attending divine service.

In 1634 the Czar forbade the use of tobacco in Russia, for the singular reason that several destructive fires in Moscow had been caused by smoking Muscovites — the first case on record of "the hired man's pipe." Transgressors were punished with the knout or with long terms of imprisonment. Tobacco was rather under the ban in Russia until 1697, when Peter the Great revoked the edict against it.

One of the Sultans of Morocco proclaimed, "Our grandfather, during his reign, prohibited the sale and culture of narcotic plants in all his dominions, and caused existing crops to be destroyed. Our father — the sanctified one — pursued the same course. But this proposition did not remain in force," he naïvely explains, "because of the financial condition of the treasury (a war indemnity had to be paid) in order not to burden the people with too many contributions. To-day, however, we have decided in like fashion to prohibit the use and culture of these pernicious plants!"

Priests and Sultans in Turkey and Persia declared the use of the weed a sin against their holy religion, and Turks and Persians soon became inveterate smokers. Its use was forbidden in China, but there, too, it became a common practice.

The careful cultivation of tobacco, on a commercial scale, was also first practiced in America.

The Spaniards first raised tobacco in Yucatan, and, in 1580, began raising it in Cuba.

The cultivation of the weed in the Colony of Virginia is variously stated to have begun in 1585, 1611, and 1612. In 1619 there was such a demand for the weed that even the streets of Jamestown were planted with it, and regulations were made to induce the planters to raise more food and less tobacco.

In 1622, 60,000 pounds were raised in the colony, and, just before the Revolution, 96,000 hogsheads of tobacco were imported from Virginia into England alone, on which the import duties were 331,675 pounds sterling, or about one million, six hundred thousand dollars. While the combined duties on importations into England, under Queen Elizabeth, scarcely amounted to 1,500 pounds sterling in 1590, they rose to 120,000 pounds in 1676, from tobacco alone.

"A true history of tobacco," says Mr. Moncure, quoted by John Fiske, "would be the history of English and American liberty." And a recent writer in the *Spectator* says, "The new herb had many enemies. Prudent persons thought, not without reason, that it was imprudent to stake the future of the colony on what might be a passing fashion. Attempts were made to limit the cultivation, in favor of more useful products. The greedy hands of monopolists were stretched out to grasp it. One act forbade any planter to raise more than 2,000 plants in one year's crop. King James I constrained the company at home to introduce not less than 40,000 pounds a year of Spanish growth (to lessen the demand for Virginia tobacco). Charles I tried, but in vain, to get all the trade into his own hands. But tobacco and liberty were too strong for him."

Tobacco, in the Virginia colony, was the money used in trade. In 1620, before our Pilgrim Fathers landed on Plymouth Rock, ninety young women of respectable character were brought to Virginia, each chargeable with the cost of transportation, which was 120 pounds of tobacco, a debt cheerfully discharged by those tobacco planters who married them.

Forty years later, we find the Virginians persecuting those who harbored Quakers, by punishing with a fine of 5,000 pounds of tobacco whoever brought a Quaker to live in the colony, or who entertained one in or near his house to preach or teach. It cost more, in those days, to harbor one Quaker than to buy forty-one wives. Since then there has been less disparity in these quotations.

In one year the tobacco crop was a partial failure and the colonists proposed to pay their ministers and priests in silver, instead of tobacco, but the ministers and priests protested against contracting debts in one kind of money and paying then in another kind, carried their point, and were finally paid in tobacco of standard weight and fineness.

This is not the time and place to go into the history of the culture and use of tobacco. I allude to these things merely to remind you that this history is full of interest to the moralist, the physiologist, and the political economist.

No plant has been so spoken against; no other plant has spread so widely in cultivated lands; none has paid so large a share of the expenses of government, and no other is used to-day by so large a number of the human race. I say this to show the economic importance of the crop; not at all in defense of the use of tobacco, for the discussion of that matter is quite beyond my purpose.

From now on, I wish to briefly notice the methods of raising and curing tobacco for use as cigar wrappers and fillers, the industry in which Connecticut tobacco-growers are chiefly interested.

I can do little more, in the allotted time, than to give an outline picture of the methods of culture in Sumatra, Cuba, Florida, and Connecticut, passing by much that is of importance, and only hoping that the recital may have something of interest to us all, and some suggestions of value to Connecticut tobacco-growers.

The Sumatra leaf is small and has a particularly fine, silky texture, admirably adapted for use as the outer wrapper of cigars. A pound of these leaves will wrap several times as many cigars as a pound of our Connecticut leaf. Much of it has, however, when smoked, a bitter, unpleasant taste, easily recognized by any one who has any experience in its use.

The Island of Sumatra, which, with Java, Borneo, and Celebes, forms the Sunda group, belongs to the Dutch East Indies. Sumatra lies next southeast of the continent of Asia, and is directly under the equator. A mountain range, with twenty volcanoes, runs through the island, which is traversed by large rivers. It has a very uniform temperature, and about twice the annual rainfall that we have. Rain falls in every month, but most abundantly in October, November, and

December. The soils are of volcanic origin, some slaty, others loamy and sandy.

The great tobacco estates are not owned by the companies or individuals who grow tobacco, but are leased from the Sultan for seventy-five years, at an annual rental of about thirty cents per English acre. An estate, to be profitable, must contain at least 7,000 acres.

The only good tobacco lands are covered with thick jungle, till within a year of the time they are planted. The first thing done is to construct a good road through the middle of the estate, to the nearest river or railroad freight depot. The slide shows this road in process of construction. It is well made, 24 feet wide, with drainage ditches on either side, three to six feet wide, and two and a half feet deep. Smaller branch roads are made bordering all the fields. The large trees are felled by the company; the land is divided into fields, of one and one-third acres, and each of them bordered on the sides by drainage ditches. This slide shows the land bordering the road after the large trees have been cut, ready to be turned over to the coolies. Each field is in charge of one Chinese coolie, who does all the work of clearing, planting, cultivating, and harvesting, and is paid according to the number of plants which he delivers at the curing barn and the quality of the plants. All these coolies are imported from China, and the company must transport them, build sheds for them to live in, and must provide physicians, medicine, and hospital facilities. The stores are kept by the Chinese, but the prices charged are regulated by the company to prevent extortion as much as may be. The expenses for superintendence are large. Previous to planting, roots are grubbed out and the field is worked over to a depth of one foot, chiefly by hand; sometimes, however, buffaloes are used for plowing. This slide shows, rather indistinctly, the buffaloes at work. Before setting, the whole is carefully smoothed and raked.

Each coolie makes his own seed bed, the company furnishing the seed. The first seed is planted in January, and in from forty-five to fifty days is ready to be transplanted to the field, which is done all the way from the last of March till early June.

The laborer must set the plants at a prescribed distance. If he crowds them, they are pulled up by the foreman and he must do it over. The planting is done by hand, much as it

was done here before the introduction of planting machines. The plants stand in rows three feet apart and two feet apart in the row. About 300 are set at a time, and, in all, each coolie sets and cares for 10,000 plants. Immediately, each plant must be sheltered by a shade plank, like a shingle, seven or eight inches long and about five inches high when set. They are set slanting over the plant, inclined to the east, so as to keep off all but the morning sun. In ten or twelve days these can be removed. This slide shows the shingles or boards set up to shade the tender plants.

The field is cultivated three times, always by hand. The coolie at the first cultivation, when the plants are nine inches high, makes a ditch about four inches deep between rows, heaping the earth carefully about the base of each plant. When the plants are twelve to fifteen inches high, he cultivates again. This time he pulls off the lowest leaves, lays them carefully around the plant and puts earth on them, being exceedingly careful to cover the joints where leaves have been taken off. All suckers are also broken off and buried. The third cultivation is done when the plants are two feet high.

Fertilizers are almost never used. Three hundred pounds of guano, mixed with the same quantity of ashes, are in rare cases applied to a field, and, sometimes, a kind of cotton-seed cake.

Topping and suckering are done about as we do it, leaving fifteen to eighteen leaves on the plant, sometimes as many as twenty-four.

About three weeks after topping, and from seventy to ninety days after setting in the field, the crop is harvested. Formerly the whole plant was cut and brought to the shed, but lately it has become a common practice to pick half the leaves and bring them in baskets, making a second later picking of the top leaves.

Often a second sucker crop is grown, for which the coolie receives half price.

The plants are hung on sticks, each of which holds ten plants, and are put in the curing barn much as we do it here. A barn 72 feet wide by 180 feet long and 36 feet high to the ridge will hold 45,000 to 50,000 plants.

This slide shows the building of a Sumatra curing barn. The material used comes almost wholly from the jungle. The barn is not very substantially built, for it is only used for two

years. Then others must be built, nearer to the new tobacco fields. The roof is what is called "attap," made by bending the leaves of a kind of palm over a bamboo pole six feet long. The whole is about one and a half feet wide, so that one bundle covers about nine square feet. These are tied to the frame by rattan strings.

A watchman tends each barn night and day, watching the curing very closely, opening the doors and ventilators about 8 or 9 o'clock in the morning and closing them at evening. The nights are too moist to make it safe to leave the shed open. In wet weather it is sometimes necessary to put fires under the tobacco, to keep it from rotting.

In four or five weeks the leaf is cured and stripped from the stalks. The top and bottom leaves are kept separate and the ragged, black, and heavily speckled leaves are separated, but no other sorting is done before fermenting. All the leaves are tied in "hands," as with us, about fifty leaves going to a single hand.

The tobacco is fermented in a shed, usually about 240 feet long by 60 feet wide, 36 feet high to the ridge pole and sloping gradually to 16 feet at the eaves. The picture gives a distant view of one of the buildings used for fermenting the leaf. It is much more substantial and expensive than the curing barns. Both sides are filled with glass windows, to secure plenty of light. Through the middle of this fermenting barn runs a platform about 180 feet long and 30 feet wide, and raised three feet from the ground. On this the tobacco is fermented in piles of three kinds: the quality or top leaves, the bottom leaves, and the ragged tobacco. It is not put into cases, but on the platform piles are made of varying height, according to the kind of fermentation desired, these piles usually being from 4 to 6 feet high. A hollow bamboo rod is inserted in the middle of each pile, in which a thermometer is placed, to note the temperature. When the temperature has gone up to 100, the pile is taken down, cooled off slightly, and a new pile is made, care being taken that the bundles formerly on the inside shall be placed outside, to give the whole an even fermentation. This time the temperature is allowed to go higher, until it finally reaches 130 degrees, when the process is stopped, but it will not do to let the temperature rise rapidly to this point, as the quality of the leaf will suffer. Much depends upon the skill of the operator, and

often the piles must be made over quite a number of times before the process is finished. This shows the barn with the piles or bulks of leaf tobacco in process of fermentation.

The so-called "fat" or quality tobacco, made up of leaves from the second half of the stalk, has to be treated differently from the dryer bottom leaves. It cannot stand as much heat, and must be fermented much more gradually; therefore, the piles of choice tobacco have to be more frequently taken down and rebuilt, in order to obtain the light colors which are desired.

Sometimes, after sorting, certain grades are re-fermented, in order to improve the quality. The final sorting immediately follows fermentation, and infinite care and pains are given to this operation. This picture shows the coolies sorting the fermented leaf. At the left is the platform from which the tobacco has been taken. The coolies are at work on the sides of the building, where the light is good. In the first place, the tobacco is divided into the following grades: brown, dark gray, light gray, yellow, multi-colored, coarse not speckled, slightly speckled, dark and brown slightly speckled, gray and light speckled all colors, little broken dark and brown, little broken gray and light, much broken all colors, sweepings and trash. These are only the usual grades, but some estates subdivide even more. Then, each of these grades is assorted as to length, making four divisions of each, namely — from 16 to 20 inches, from 12 to 16 inches, from 9 to 12, and from 6 to 9. Each grade and length is then pressed into separate bales, each containing 176 English pounds and having a thickness of about one foot. The bale is marked with the name or trade-mark of the estate, and with the grade and length of leaf, and is then ready for shipping.

A considerable part of the value of the Sumatra leaf in commerce depends upon the fact that it has been sorted with infinite care, and that all the leaves in each bale are of uniform length and quality. There is absolutely no waste about it.

This is the chief lesson for us, from the Sumatra tobacco business: it pays the grower to handle his leaf with the greatest care, to sort carefully, and never to grade a leaf higher than it should be.

The production of Sumatra tobacco at its maximum was 41,500,000 pounds annually, and in 1896, the last year for which I have statistics, was 33,648,000 pounds. In 1894,

6,163,000 pounds of Sumatra tobacco were imported into this country, having a total value, exclusive of import duty, of \$7,517,000. Some of the estates have lost money and gone into insolvency; others have made enormous sums, for instance: A single estate, whose stock at par was 100, has been quoted all the way from 400 to 1020, during the seven years from 1888 to 1895, and has paid an annual dividend of from 14 to 152 per cent.

As to the coolie laborer, the less said the better. He is a single man, imported from China at a cost to his employer of \$10 per head. He lives with nine others in a shed 18x36 feet, and does his own cooking in a general kitchen. He works ten hours daily and has lodging and medical attendance free. He must pay for his own implements at cost price, and \$4 in cash for cutting the large trees on his field. He must sell his tobacco to the company, and he receives, on the average, about \$66 for his year's work in the fields. He is also paid for stripping and tying into hands at the rate of eight cents per hundred bundles; for sorting he receives 24 cents per hundred bundles, which must be divided between himself and two helpers.

The soil on which the crop is grown must go back to jungle before it can be used a second time for the crop. Formerly it was allowed to run wild for twelve years, but now, owing to the increased demand for tobacco, it does not rest more than five years at a time. So much for Sumatra, the great rival of our Connecticut wrapper leaf.

Now let us turn to other rivals, nearer home. Of the Cuban methods of planting, cultivating, harvesting, and fermenting we can judge fairly well by observation in Florida. The Cuban Tobacco Growers' Company at Fort Meade, Fla., is managed by Cubans familiar with the methods used on the island, employs Cuban labor almost exclusively in the fields and curing houses, and follows closely the practice learned in Cuba. This company has already turned out 68,000 pounds of finished tobacco this year, and has a second crop nearly ready to harvest.

The soil of these Florida plantations is light and sandy, containing some humus. It is rather finer in texture than our Connecticut soils. The best of them were covered from time immemorial, until cleared for tobacco, with oak, hickory, live oak, and magnolia.

This slide shows the characteristic growth on those hummock lands, which are the best soils for tobacco. The next shows the first quality pine land, one of the best soils for tobacco. The next is high pine land, not quite as good for tobacco, but best for truck farming.

Seed beds are made in a rough clearing surrounded by woods, which protect from light frosts; the seed is sown here in January, and the plants are set in the fields early in March, at the rate of about 15,000 to the acre. The fields are cleared by felling the timber and burning everything on the land, which, of course, furnishes abundant potash to the crop. The only fertilizer used is about 450 pounds of Peruvian guano per acre.

All work of clearing land and cultivating the crop is done by hand. The machete, of which we have heard so much in Cuba, is of great value in cutting up vines and bushes, and cultivating is done with a short-handled, very heavy hoe, which no Connecticut farmer could be hired to use. The man who swings it must bend himself nearly double at his work. I was interested to note that these two tools, brought over from Cuba, were made at Collinsville, in this State!

This slide shows new land being cleared for tobacco. The heavy growth of timber has been cut and will now be burned where it lies, thus supplying the crop with abundance of potash.

Here is a new clearing nearly ready for setting.

Here is a seed bed, very roughly and incompletely cleared, but surrounded by woods which protect it from light frost.

On these plantations the crop is irrigated, when necessary, from stand pipes 6 to 7 feet high, having a spraying fixture which distributes a fine rain over an area 60 feet in diameter. An underground system of supply pipes is connected with a powerful steam pump at the river — from an abandoned phosphate mine — by which this irrigating water is forced over the farm when needed. By this means, all danger from drought is avoided.

This is a view of the plantation taken after the first crop was planted. It appears as if president, directors, and stockholders were all engaged in watching the crop grow.

Another view of the plantation. The fields seem to be kept quite clear of weeds, and the plants are hilled up, but not as much as here in Connecticut. At topping time only eight

to ten leaves are left on average plants, though, of course, the number varies with the fertility of the soil and the vigor of the plant. At harvest the plant has an inverted cone shape, the largest leaves being at the top.

The first crop is gathered in early June. The stalk is cut in sections, each with two leaves, which are hung close together on poles, the leaves astride, as it were, and leaves of like character being hung on the same pole, making a kind of preliminary sorting. The poles are carried by hand and put in place in the curing barn. These barns are built in the fields and are considerably smaller than ours, having some ventilators, but no means for supplying artificial heat or moisture. Sometimes they are thatched with palmetto, as shown in the picture. The wrappers are kept housed till cured, but the fillers are occasionally brought out and hung in the sun and air for a part of the day, as shown in this photograph, but are always housed at night. During this barn-curing the crop is closely watched, but "pole-burn" seems to be unknown.

Now, when this first crop is cut, a sucker or bud is left on the sunny side of each butt or stalk, which immediately starts to grow and yields a second crop, sometimes in forty-five days, being provided with a strong root system and favored by the rains, which are more abundant from June on through the summer. Even a third crop may sometimes be grown from the plants first set in the field in February or March.

The first cutting of each crop consists chiefly of wrappers; the second and third cuttings are mostly fillers. It is stated that an acre of land should yield 1,250 pounds of leaf annually, of which one-fourth should be wrappers.

Regarding the process of fermenting the leaf, great secrecy is observed by the professional curers, and no details concerning it can be given. During or after the fermentation the leaves are "betuned," that is, sprayed with a mixture, whose composition is not revealed, but is believed to consist of water, rum, sugar, and, possibly, other ingredients. This imparts a distinctive odor to the leaves, and possibly affects their flavor. These methods and processes are, doubtless, quite like those followed in the Island of Cuba.

The flavor which is imparted to the leaf by the tropical soil and climate we cannot, of course, secure here. But careful experiments in curing and in fermentation, which are being made here and elsewhere, will leave, I think, nothing

in the trade secrets of professional fermenters of the leaf which is worth the having. At any rate, the next advance in our wrapper leaf tobacco industry will be in improved methods of curing and fermenting.

The photograph shows a Cuban laborer's house and family. It is rather indistinct owing to the fact that it was taken as we drove by, and just after a stormy interview between the family and a man who wished to sell them a sure cure for consumption — all the more stormy because neither the peddler nor the family could understand a word of what the other said.

Now, from this district, let us go to Quincy, in western Florida, where there is much to be learned regarding the fermentation of tobacco. Incidentally, we may note that not only is Havana tobacco grown here in western Florida, but also Sumatra leaf, which compares very favorably in quality with the imported leaf, and which, in my experience, has less of the bitter taste which is so marked in imported Sumatra. In other parts of Florida, too, some Sumatra leaf is being raised, and, while still in the experimental stage, the results make it likely that we may in time compete with Sumatra in supplying our home market with this kind of leaf.

The methods of clearing the land and raising the crop in this section of Florida do not call for detailed description.

The picture shows a field lying on a hill-side, and the rows are made to follow the contour of the hill. This is to prevent gullying or galling, which is sure to follow running the rows up and down the hill. The heavy rains would tear the light soil of the field and wash it away.

In harvesting the crop, *all* the leaves are picked by hand and carried in baskets to the curing barns — one of which is shown on the screen — where they are strung on cords, which, in turn, are stretched on lath, forty or fifty leaves per lath, and hung four to six inches apart in the curing barn, much as we do. White vein and pole-burn are, apparently, unknown, but the curing is done much as we do it.

In the matter of fermenting tobacco, the Owl Cigar Company — which owns 17,000 acres of land in western Florida and has about 1,000 acres of tobacco — has shown great enterprise and skill and has demonstrated that excellent "Cuban" tobacco can be raised in Florida, and can be successfully cured

and fermented without any trade secrets, or imported professional fermenters, or mysteriously made betunes.

The curing and fermenting is done by Americans, Florida men, who have devised and perfected the methods, which have given excellent results. They have no secrets about it, are quite willing to tell what they know, but skill and experience, which are the key of the whole thing, cannot be imparted by word of mouth.

The fermenting house is perfectly equipped for its purpose, and in all its arrangements and the conduct of the operations is a model of absolute neatness, order, and good management.

The rooms where the tobacco is handled over in any way are steam heated, so that the temperature can be kept at the desired point night and day. Without noting the thermometer, I should say none of them were below 70 or 75 Fahr., and the air is kept very moist with escaping steam. Tobacco lies loosely on the tables, without drying out at all.

The tobacco is "bulked," immediately for fermentation. The aim is to "cook it in its own juice," and no blowing or dampening of the leaf is allowed. This is regarded as vital to success.

A "bulk" is made by covering the floor with trash tobacco, fermented cuttings, etc., about six to eight inches deep. Uprights, to which boards can be attached as the bulk is built up, hold it in place. On this trash tobacco the leaves are laid, tied in hands. Trash tobacco is also laid next the side boards. The bulks which we saw were from five to six feet or more high, and when made are covered with trash tobacco and blankets.

The temperature of the pile rises rapidly and sometimes will reach 180 Fahr. in the center. When the expert judges it necessary — in extreme cases within twenty-four hours after the bulk is built — it is all handled over and built again close by. The leaves which were in the middle of the first bulk are put on the outside of the second. The aim is not only to make the fermentation even for all the tobacco, but each hand of tobacco is shaken out when the pile is made over, as, otherwise, the leaves will stick together and be uneven in color, and it may be impossible to pull them apart without tearing, when the whole process is complete. It may be necessary to repeat this turning of the bulks six or eight times before the process

is complete. Often two bulks are mixed, if one is rather damp and the other too dry.

When the fermentation is done, the leaves are very carefully sorted, as to both size and color, are tied into hands, these put in *carrots*, and baled to "age" for one or two years. They are first put into a warm room to cool down, and, finally, into a cooler storage.

The sorting, as shown in the picture, is largely done by negro women and children. The places for laying leaves, when sorted by size, are well shown in the foreground. These women are not paid more than 50 cents per day; the pickaninies still less.

The next picture shows the making up of carrots. Each carrot or bundle of leaves is four or five times as large in diameter as a "hand" of Connecticut leaf, and is bound together with a vegetable fiber, which is shown lying about the floor and hung up near by. These carrots are made to imitate the Cuban packing just as closely as possible.

This shows the baling of these carrots. The covering is a sheet of vegetable fiber, imported from Cuba for this purpose, and two men are cording it tightly together. The whole will look, when finished, exactly like a Cuban bale, and it is more than likely that, after considerable travel, it will appear at Key West, as having come from the choicest plantations in western Cuba.

Here is the old plantation house, used by the directors of the Owl Cigar Company for their meeting, and also for entertaining most hospitably their guests.

The last picture of this series shows typical houses of plantation laborers. Two families occupy this house. Glass in the windows is uncommon. The window is closed with a wooden shutter, and at night, when the family are all within, the shutter and door, tightly closed, keep out ghosts and malaria and keep in chicken thieves.

I come now to speak of tobacco growing in this State, not at all for the information of those who raise this crop and who are more familiar with it than I am, but for those who do not appreciate the extent of the industry or its share in Connecticut farming.

About 700,000 acres of land are devoted to tobacco culture in the United States, producing annually 496,000,000 pounds. Of this Connecticut devotes to tobacco 8,000 acres, and has an

average annual crop of, perhaps, 14,000,000 pounds, which brings to the farmer this year at least \$2,100,000.

At present it only pays to raise leaf suitable for use on cigars as wrappers and binders. There is no other crop raised in which fine differences in quality make so large a difference in selling price, in which so much depends on careful cultivation, handling, and curing; no other which may be so suddenly and completely ruined by a storm which is not of unusual occurrence or severity. The color of the cured leaf, the way it burns and holds fire, the texture of the ash left after burning, the texture of the leaf, as well as its flavor, all these are points of great importance and determine the profitability of the crop.

The crop can only be grown with profit on thin, light soils, which need annually heavy dressing with fertilizers, yet many fertilizers which can be used on other crops are ruinous to the quality of tobacco leaf.

I think we may safely say that nowhere in the country is the crop more carefully and skillfully raised than in this State at the present time.

Laboratory and field experiment have gone hand in hand as helpers and not as substitutes for practical experience in tobacco growing.

In 1892 many of our growers joined in organizing a stock company, for the purpose of making experiments on the growth, curing, and fermentation of tobacco. An experimental field was bought, a curing barn put up, and for five years experiments were made on the effect of fertilizers on the quality of tobacco.

Since then we have experimented for two years on the curing of tobacco, with the aid of heat, and on the fermentation of the crop, a process about which little or nothing is accurately known, which is at present conducted in a haphazard way, but on which greatly depends the quality of the crop and its value to the manufacturer of tobacco.

We can never hope to raise in Connecticut tobacco having the fine flavor and aroma of choice Cuban crops, but we can, if we will, raise a leaf which will be a much better wrapper than what we now produce, and one which can compete on more equal terms with the imported article.

In conclusion, I wish to show a series of views, mostly taken on the field of the Connecticut Tobacco Experiment

Company, which illustrates the growing of the leaf in this State.

The first shows the tobacco seed beds, where the plants are started in early spring, under cloth or glass. The plants here shown are about ready to transplant into the field.

This shows the field rowed out for planting, and four men setting the plants by hand, and watering them.

The next view shows the same laborious operation.

This is the planter which, in one form or another, is now extensively used by those who have a considerable acreage of tobacco. The driver goes slowly across the field on the line marked by the machine at its last trip. Two boys sit behind, with a box of young plants before them, and alternately put in a plant at the proper moment. The machine opens the furrow, waters it, covers the plant roots and firms the soil down over them.

This shows another view of the planter.

Here is a tobacco crop just started, and getting beyond the stage where plants are destroyed in one night by cut worms, making it necessary sometimes to replace missing plants half a dozen times.

Here is the same crop, half grown and as healthy and lusty as one could wish.

Here is the same field about the first of August, when the crop is ripe and ready to harvest.

Next is an attempt to show the method of cutting the crop. Each plant is cut near the ground, with a hatchet, and carefully laid on the ground to wilt. The picture was a poor one to begin with, and the glass negative broke, which accidents make the picture disappointing.

Then follows the spearing and hanging of the somewhat wilted plants on lath. The whole process, shown in the picture, hardly needs explanation.

This other picture shows the tobacco cart on which the lath are hung and carried to the barn.

The next shows another view of, essentially, the same thing.

Here is a typical Connecticut Valley tobacco barn, well built, with some of the ventilators opened, to show how they are constructed.

The next view shows, rather indistinctly, the interior of

the barn and the arrangement of poles, across which the lath are hung which carry the tobacco plants.

This is an attempt to show the way in which the crop is hung up in the curing barn. From every acre of tobacco land about 25,000 pounds — or $12\frac{1}{2}$ tons — of green tobacco plants must be passed up in this way to the poles. Of this weight $9\frac{3}{4}$ tons, consisting of water, pass out of the doors and ventilators during the barn cure, leaving only about one-fifth of the weight to be taken down when the barn cure is complete — say — 1,800 pounds of leaf tobacco and 3,700 pounds of stalks.

A picture of our barn, where the experiment crops were cured for five years and which was destroyed by fire in 1897.

The new experiment barn, built in 1898. The lean-to on each side of the barn covers a furnace for heating the barn during the cure, and these furnaces connect with a chimney in the center of the barn.

I have three other pictures which I have received permission to use, which convey a lesson too obvious to need any explanation.

Let us turn back a moment and look again at this view of a Florida negro laborer's house. There he was probably born, there he lives, and there he will die.

Now, let us look at this first house of one of our Connecticut tobacco-growers. What is the difference? It may be doubted whether the two buildings *in themselves* are very different in the protection they offer from the weather; yet they are as different as heaven and hell. In the first one the inmates are joyless and content; in the second they are happy and have, at the same time, a holy discontent. Both conditions of mind are epitomized, I think, in the flowers and vines, which make the rudest dwelling picturesque.

Here we have the next result of health, hard work, and holy discontent. The house is comfortable, there is a well-trimmed lawn in front, and a few fruit trees are starting to grow.

And here is the same place, after fifteen years of work early and late in the tobacco fields. Some of you will recognize the place, but I introduce it here only as one illustration of many other cases which could be cited which show that, in spite of statistics, in spite of the talk of hard times and of

abandoned farms, in spite of financial depression and increasing competition, Connecticut farming does pay to-day.

Farming is hard work, the profit is small, and sometimes work involves only loss — that is certain. And the same is true of manufacturing, of brokerage, of practicing medicine, of any honest business. Life is hard and always has been — when it amounted to anything. What of it? A horse with a heavy load will either lie down in the traces and give it up, or he will stand still, lay his ears back and balk and kick till he is hungry, or, with a look in his eye which makes you love him, he will do every last thing which flesh and blood can do to pull through to the end.

No one of us has yet done the very last thing. We have not yet resisted unto death. We should remember that we are creative. We are not the creatures of circumstances, the playthings of fate. We can make our circumstances; we can control our fate.

And Connecticut farming is not doomed to decay till the hope, the courage, the skill, in a word, the manhood of our farmers, have decayed. Do we admit that this has come? Not in the least. It is not a time for despair, or depression, or a faint heart, but for a revision of our ways of farming, our business methods, for proving all things and holding fast, not what is ancient, but what is good; for eagerly seeking after new agricultural truth; for doing our work, not only "with ancient sinew," but "with modern art."

Sec. GOLD. Are there any questions to be asked of Dr. Jenkins? There is an opportunity now if anybody desires to ask him any questions upon the subject of his valuable paper.

Col. WOOD. I would like to ask the gentleman what the average return is, per acre, to Connecticut tobacco-growers?

Dr. JENKINS. It is impossible to say what are the profits from the crop. That is the trouble with a good deal of our farming. We know we have worked hard all the year, and the family has been supported, and the place kept up, but when you ask one of our farmers what his profits are he don't know how to figure it. This year some of our farmers have got 1,800 pounds of cured tobacco per acre, and some more than that. Some of them have sold for twenty cents a pound,

some for twenty-four or twenty-five cents. You can figure what the income from the crop is, and for the rest you have to guess. Fertilizers cost from \$60 to \$90 per acre, and the crop is an expensive one to plant, cultivate, and harvest. It is to be remembered that, while in certain years the profits are large, in other years a man may have his whole season's work for his pains. A hail storm or high wind may ruin the crop so that the farmer might just as well plow it under. His tobacco crop may be absolutely ruined by a storm which does not appear to seriously injure certain other crops.

The CHAIRMAN. (Mr. Seeley.) I believe if we were to get an answer from twenty men in this room in regard to the profits of tobacco raising they would all differ somewhat. Now, from my own observation, — not from my own experience in raising it, for I never raised a plant in my life, and never had a plant raised on my farm, — but from my own observation in and about the town of New Milford, where tobacco has been raised since I was a small boy, nine-tenths of the men who have been engaged in that business are not as well off to-day as they would have been if they never had raised a plant of it. Some of them have been successful for awhile, and have accumulated money, and have been building all the while, but after a time there comes some disease, some storm, such as hail or wind, that ruins the crop, and the growers commence to slip behind and get discouraged, and they rarely recover their lost ground. I am speaking of the most favorable circumstances that I can recollect in the vicinity where I reside. Nine-tenths of those farmers would be better off if they had never raised a leaf of tobacco. I will give you my reasons. It is because they have abandoned their former practice of good farming; of attending to their fences, cutting their bushes, and being, through the season, industrious and economical, having a variety of business, and not depending on any one specialty, and they have lost money. Well, you say, times have been bad. That is true, but I can

recall to mind men who have kept out of the tobacco business who commenced with very little capital, and mortgages on their farms, who have been steadily climbing up the hill all the time because of the increase in value of their property through good farming. I believe that taking a radius of two or three townships about me and the farmers are in worse condition financially from having attempted to raise tobacco than those who have not raised it.

Mr. WADHAMS. What particular branch have those farmers engaged in whose farms can be sold for more than they could ten years ago?

Mr. SEELEY. I do not want to be misunderstood, because I know there has been a good deal of depreciation in most all farm property, but what I meant to say was that those farmers are in better shape, although not worth as much, because there is hardly anything in the way of farming property that is worth as much to-day.

Mr. GOLD. I want to give the result of my observation in regard to the tobacco crop. It is a crop that demands the closest and most persistent attention, and it makes a perfect slave of a man who devotes himself to it, but when he is successful it is the most remunerative, money-bringing crop in the State of Connecticut, or in the country, perhaps. It holds a man in its grasp who starts out to raise it. There is a market in New York for many of our farm and dairy products which will pay well, and you can get rid of watching the tobacco crop with all its dangers, tribulations, and sufferings. It is a crop where we are rich to-day, and to-morrow, half a minute, as we have heard, is long enough to make us poor. It may be ruined in the field by the elements, or go up in smoke long before the intended time. But when a town or a neighborhood can take land that is not worth much in ordinary agriculture and, by applying \$100 worth of fertilizer and \$100 worth more of labor, and get \$500 in return, why that is the land which is going up in value. Some of this worthless, valueless land for ordinary agricultural purposes

is producing the highest return of any land in the country. It is a hard matter to decide, but the profit of tobacco raising is large for those who make a success of the crop.

Convention adjourned until 10 o'clock A. M., December 14th.

MORNING SESSION.

Wednesday, December 4, 1898.

Convention called to order at 10 A. M., Mr. Seeley in the Chair.

The CHAIRMAN. I have read that on some of the mountain slopes of Switzerland, and up the craggy mountain sides are to be seen growing plants of various kinds and varieties. Gardens of beautiful flowers. It is said that women have carried the soil in baskets to those barren spots, and thus have gradually changed and transformed those rugged hillsides until they blossom like the rose. It was my good fortune, a few years ago, to see a person who was doing something in the same line in this country. Not exactly the same thing, but out here a little way west of us he took it into his head that grass would grow on some of those rough and hilly uplands, and so he began to get together all the different varieties of grass that he could find and experiment to get the best ones suited to his purpose. It is about ten years ago that I visited his place, and I found that he had staked off different sections for raising different kinds of grasses, and it is that very gentleman that I am now going to introduce to you, Col. James Wood of Mt. Kisco, N. Y., who will talk to you of meadows and permanent pastures.

MEADOWS AND PERMANENT PASTURES.

By COL. JAMES WOOD, of Mount Kisco, N. Y.

Col. WOOD. Mr. Chairman and Gentlemen: What shall we do with our rough and rocky hillsides? A citizen of Connecticut of world-wide fame, who has made men happy because he has made them laugh, once said "that New England

had more weather to the square mile than any other part of the world." I think the State of Connecticut, and that portion of the State of New York lying east of the Hudson River, where I reside, has more hillsides to the square mile than any other part of the world that I have ever seen, and I have seen a large portion of it.

The time was when our Eastern cities and towns were supplied with their food from nearby localities, and then these hillsides could be cultivated at a profit, and so our fathers and our grandfathers plowed them and raised corn, and rye, and buckwheat, and plowed again, and raised corn, and rye, and buckwheat, and they kept up the process until there was almost nothing left of these hillsides, for that, together with the washings that they always received, carried the soil down into the valleys so that there is nothing left in some places but the old skeleton of rock. Thus these hillsides have become practically valueless unless we can adopt some new means of turning them to account. Here they are. What are we going to do with them? The abandoned farms of New England that we read about generally have a good deal of this kind of area. Now times have changed in regard to the cultivation of these hills, because of the change in the source from which we procure our food supplies. As I said before, when these cities and towns were supplied from nearby localities these hills could be cultivated at a profit, but in recent times the boundless West has sent us most all our supplies over railroads and canals, at a cost of transportation that was never dreamed of years ago. So cheap is transportation now that you can send a carload of material almost across the continent for less cost than you can cart it in wagons for fifteen miles through the country. The West has dumped these supplies upon our market so cheaply and in such abundance that we have been driven out of all staple lines except under the most favorable conditions of production. This change has necessitated a change in the methods of our farming. We cannot grow grain in the East at a profit in comparison with the grains of the West that are brought here and delivered at our doors, and when we leave out special crops, like your tobacco crop of Connecticut, about which we had a most interesting lecture last night, when we leave crops of that kind out, and special fruit crops, when we put figures upon our products we are narrowed down here in the East almost exclusively to grass. Grass is

the only crop outside of special lines that can be grown on our Eastern farms at a real profit. I make that statement without any fear of contradiction from an intelligent source. Therefore, the treatment of our meadows which provide our hay, and our pasture land, which gives support to our stock, becomes a matter of very great importance.

My subject this morning is "Meadows and Permanent Pastures." A person that has not thought about this matter says, "Well, grass is grass, and we cut grass for hay, and we pasture grass on the fields. Of course, that is all one thing." But if we will stop and think for a moment we will find that the meadow and the pasture are entirely different things. Now what do we want in a meadow? We want in a meadow those varieties of grass that will grow, and which will arrive at their greatest development and greatest value for feeding purposes at about the same time. Anyone can see that there is no use in having two varieties in a meadow, one of which will have its growth and reach its greatest development for food value at a time when another grass has not made half its growth, because when you have got through with that one grass you have got nothing of the other. Or, if you let it go on, it matures its seed, it is developed, and becomes of almost no value for feeding purposes. Therefore, those two things cannot go together. You must have for your meadow those varieties of grass, if you have more than one variety, that reach their greatest development at about the same time. Now it is found in practice that the growth and development of the average plant in timothy and clover, when grown together, approximate more nearly to this condition than do most other varieties. Clover appears to be earlier in its development than timothy, but the fact is that clover wants to arrive at a pretty good state of forwardness before it has attained its greatest value, while timothy has attained its greatest value long before the ripening of the seed. So those two go together very harmoniously.

Now what do we want in a pasture? You want a diametrically opposite state of things exactly to what we want in a meadow. You do not want varieties of grass that will come on together, and reach their greatest development at one time. If you have your pasture seeded with those varieties you will have good grass for awhile, and during all the rest of the season you will have no growth. No, what you require in a pasture are

varieties of grasses that reach their development at different times in the season. Beginning with those which grow and develop at the earliest possible period in the spring, and followed by others that reach their growth and development in the summer, and others that make their greatest growth in the fall, or, as is usually the case, those that make their greatest growth in the spring, will make another in the fall, so that you will have through the season, from the earliest possible period in the spring up to the latest date in the autumn that you want your pastures, a fresh, new, luxuriant, nutritious growth of your pasture grasses. It is only under such a condition that you can have a perfect pasture, but the same treatment that will give you that condition will give you the best pastures that you can have under the condition of your farms.

Now, first, let us treat the subject of permanent pastures on these hillsides that have become, under the old system, perfectly valueless. Of course, the first thing to do with these hillsides is to get them into a condition so that they can grow grasses for a permanent pasture. Now, it is not worth while for us to come forward with a pet theory as to how we can restore fertility to the soil in a general way, because many of these hillsides are so located, and they are so rocky and so stony that we cannot plow them in the way we plow land for crops, and restore fertility to them as we can to many other lands better situated. But there are many of them where this can be done. Now, on the average hillside of western Connecticut and eastern New York, I have found, and I expect it will be found so in general, that the best preparation of the soil for this permanent pasture is by, or through, the old, old system, called the "summer fallow." In these progressing modern times we have come to think, many of us, that the proper thing is to discourage everything that is old. But that is very unreasonable. They say that old things were founded on the rule of luck, while under the new we know what we are doing. But, my friends, the old system was founded on experience. Do not let us despise our ancestry. Don't let us question their intelligence. According to the experience and light they had they were as intelligent as any of us to-day. Modern science has not developed and the discovery has not yet been made, upon which we pride ourselves to-day, but what they assisted in to the best of their light and knowledge. Don't let us pride ourselves as though we had done things so wonder-

ful, and our ancestors were a stupid lot. Our ancestors based their practice upon experience, and experience, like experiment, is the foot, or foundation, of actual knowledge. The experience of our ancestors was that the way to restore land that was suffering from overwork was by the "summer fallow." They used the old English word "fallow," meaning "rest." They meant a summer's rest. Well, in one sense it was an appropriate term, because they were getting no crop; but in another sense it was an inappropriate term, because we have been taught by modern science that nature is never at rest. When you give her an opportunity to do her work; when you plow the ground, and break it up, and let the air percolate through it, nature will promptly begin her work, and instead of its being a summer's rest it is a summer of ceaseless activity, for chemical changes are going on, and the inorganic matter of the soil is being developed so that it can be used for plant food. That is what the summer fallow is. It is the scientific meeting of requirements, and it is one of the most scientific things you can apply to the practice of agriculture, although you allow nature to do the scientific work instead of the labor upon which we so pride ourselves in recent times.

Now, how is the summer fallow useful? It depends upon your soil. How does it work on the hard loamy soil of our section of the country? I say "our," because geologically the whole district east from the Hudson River through Connecticut is practically one thing. There are local variations in the soil, but the whole region is practically one thing east from the Hudson River. West of the Hudson River there is a complete change. From that great chasm made by some mighty upheaval of nature which rent the country in twain, so deep in places that its bottom has never yet been found, and which for natural beauty cannot be surpassed even in the rocky mountains of the West, from that great chasm through which the Hudson flows, westward there is a complete change in geological formation. I, therefore, speak of the eastern section as our section. Now, the summer fallow we want to carry on, and, by the way, this change of conditions I have spoken of makes a change on our part in the labor necessary. You can do almost anything with sufficient outlay of money. People sometimes say, "How have you done this?" Well, I do not want to tell them, because I have probably spent on ten acres of land more than the ten acres are worth to-day, and I

do not want to recommend any farmer to go into that practice. Now, how can we carry on the summer fallow most cheaply? My own experience is this: that where the season is open, and the spring comes on so that the frost comes out in February or March to the depth of five inches or so, and even though the frost may be in the ground a foot, or two feet below that five inches, I have put my plows on and worked on that land with the least expenditure of power with frozen ground underneath, and broke it up to a depth of from three to six inches. If you do that on clayey soil the sun will dry it and you will have sun-dried brick of every color, but on loamy soil that is the cheapest plowing that can be done. Our fathers did not have the best implements to plow on these rocky hillsides, but the modern improvements in agricultural implements make a much cheaper method of doing the same thing. The greatest implement for doing that work is the spring-tooth harrow, and the harrow is the implement for the summer fallow. On these rough and rocky hillsides, stony and tough, plowing is very expensive oftentimes, but the spring-tooth harrow can be sent over this ground very frequently through the season, the soil somewhat changed by these operations in it which are going on, and by the first of September the soil is in the best possible condition to receive the seed. Now, if you can at that time give it a dressing of well-rotted manure, or commercial fertilizer if you please, containing especially potash or phosphate. Of course, it will be deficient in nitrogen, but nitrogen you will obtain from the action of the air upon the vegetable matter that is in the soil already, and to a certain degree by this summer fallow. That is one of the things that the summer fallow accomplishes. Nitrogen from the air will be taken up by the soil, of course, aided by those plants which are especially suited to the acquirement of nitrogen in the soil. That, however, is not my subject. It has been demonstrated, however, that plants do take nitrogen from the air. Modern science has developed the fact, beyond a possibility of doubt, that this is done. If you can furnish manure for your land do so, and then sow your grass seed the first of September, and never put a grain crop on. We used to think that we had to grow a crop. We put it on, simply rotating the grain with the other crop, and it cost us four or five times what it was ever worth. When you are going for a thing that is worth having don't stop for something else. If it is not worth anything don't go for it,

but if it is, go straight for it, and don't stop to waste your energy where you ought to expend it otherwise. If you are after grass, go for it, and not after something else. If you put in any crop to grow with that grass, you are pursuing a suicidal policy for the object you have in view. Now, why the 1st of September? If you sow your grass-seed in the spring, and your soil has plant food enough in it to make a vigorous growth, you will have a crop of weeds grown with the grass during the summer. You may mow them, and you may do this, that, and the other thing, but the prospects are that your crop of weeds will injure the grass just as a crop of corn would have done, or any other grain sowed with the grass in the first place, and in the second place you will mature a crop of seed which will fill your soil for time to come. Sow your grass-seed about the 1st of September, so it will get hold enough to stand the winter, and the next spring when it comes on there is no room for weeds, and they do not grow, and your ground is made clean and clear of weeds instead of being foul with them, as it would have been by spring sowing, and you have got it in good condition.

If your soil is of a rough, rocky character, such as I have described, one plowing, with the harrowing following, is the best possible means of preparing that soil for seed, but if your ground is tillable enough so you can plow under a crop, then your conditions are changed, and you had better spend two years instead of one in the preparation of your soil for a permanent pasture. You treat the soil the first season. You plow it, and harrow it, and then at mid-summer sow crimson clover. I speak of that with a very great deal of hesitation. My friend, Mr. Powell, is one of the ablest men connected with the agricultural interests of the State of New York, and he seems to recommend it with a great deal of confidence, but, my friends, we are just on the line limit of crimson clover. It does well enough in the South, but we are on the northern limit of where it will thrive best, in my opinion. Mr. Powell is up in Columbia County, which is about equal to the northern portion of your State. I am west of you here. It does well with him, and it does exceedingly well, although he is a hundred miles north of me, but for all that I recommend it with a great deal of hesitation because in many cases it has done only fairly well. There is a great deal of discussion as to where we shall get our crimson clover seed. We are told that

the imported seed is of an inferior quality, and so it is. We are told that we must get our seed from Delaware or Virginia. Very good. That seed is better than the imported seed, but by all means get crimson clover seed grown in your own neighborhood if you can. You can see what you pay for then. It does not make any difference what you are paying for seed if you are getting what you want. It is nothing in the world but a penny wise and pound foolish policy. Have good seed. But then, that is a subject by itself which is well worthy of a place upon your program and for a whole half-day's discussion. But if you put in crimson clover seed, mid-summer seems to be the best time to sow it, and the next season when you plow it under you get a great addition to the fertility of the soil. There is no way by which you can get nitrogen so cheaply as by plowing in a crop of this clover. Even if you cannot ascertain with scientific accuracy what amount of nitrogen is contained in crimson clover you will find it is the cheapest nitrogen you ever obtained when you add it to your soil in that way. It costs nothing except the use of the land, the price of the seed, and the labor of putting it in, and under these conditions you are reasonably sure of getting good results because you are not dependent, for one thing, upon a miscellaneous crop of seed. When you treat your soil properly you will succeed. When you treat your soil badly, and are not liberal with your soil, or with the plant that you expect to grow there, when everything is favorable you may succeed, but when some little thing is adverse you utterly fail. When you have prepared your soil as it should be prepared, and little adverse circumstances occur, it is carried right over them. There is a force, an energy in the soil and growth of the germination of the seed which enables it to take hold of the soil and carries it right over these obstacles, and where you had failure before, you now have success.

In this matter of permanent pastures, having prepared the soil as I have suggested, you come to the question of the varieties of grass that you should use. Until very recently we were entirely dependent upon European authority in regard to different grasses. We knew about our native grasses, and we knew about certain European grasses. We knew something about our redtop, and about timothy. We knew about clover, and that was about the extent of our knowledge. The French have given more attention to grasses than any other people,

but the English have also paid some attention to the subject. When it became necessary for me to go into this question I found that we were dependent upon English books, and I read that what would go in the English climate would not do in French, as the climate there was different. Now the French climate is a good deal like our Maryland climate, whereas in England, owing to the storms that strike upon the coast of Great Britain, they have a moist climate, and not as much range of temperature. You see at once, as any of you will see, that such conditions are not American conditions; that a variety of grass may be entirely different in its habits in this country from what it is in England because our temperatures are different, and our climate differs in conditions of moisture, and we have very different varieties of soil. So I could not depend upon that information.

When I came to examine the subject I found that there had been but very few tests of grasses made in America. Forty-eight years ago John Stanton Gould carried on some experiments in Columbia County, N. Y. He lived in the city of Hudson. What other grass experiments have been carried on until recent times? There are few. Our State Experiment Stations that have been doing such marvelous work for agriculture all over the country, and one of the most wonderful things in modern times in connection with agriculture is the experiment station with the ability and skill there devoted to solving the problems of agriculture, and yet how many of our experiment stations have carried on any grass experiments? I am thankful to say that you are an exception here in this State. I am informed that at South Manchester there is what is called a "grass garden." I do not quite see why it is called a garden.

MR. HALE. It is.

COL. WOOD. All right.

MR. HALE. It is a garden. You ought to go out and see it.

COL. WOOD. I don't see why you call it a garden.

MR. HALE. It is a garden. You go out and see it, and perhaps you will call it heaven, I don't know.

COL. WOOD. It may be a lawn. It may be heaven. My theology don't say; or it may be the Garden of Eden. I sup-

pose that is what you mean, and I will know hereafter. It's all right, anyway. What my friend Hale says goes, anyway. I understand that in this garden have been carried on some very successful experiments, but at the time I am speaking of it had not been started. I do not know how long ago it was that I started to look this matter up.

Your Chairman has referred to my pastures, therefore you will excuse me if I use the personal pronoun singular, sometimes now in speaking of this matter. It became necessary for me to find out what grasses were suited to my needs, and to my climatic conditions, and everything pertaining to my location and my fields. That is what I wanted to know. I want to say that I did not go into this with any broad, philanthropic purpose in mind at all. I was entirely selfish about it. I did not want to waste my money or seed down an extensive area permanently with grasses that were not going to succeed, and so I took my land and carried on these experiments. It would have been very tempting to have taken ten acres and made a garden, and then invited my friends to come and see my grass garden. But I did not want any grass in my garden. I have been fighting grass in my garden all my life. Grass is one of my enemies when I find it in the garden. You talk about the hillsides. That is where I wanted my grass garden. So I went up there and laid out my plots of land. I will tell you what kind of grasses I put out. Now you must have a fixed standard in whatever you do. It does not make any difference whether you are going to measure the distance between two points, or what you are going to do, you must have a standard of what you wish to accomplish. The standard measure of America is the yard. In the time of King Henry the VII they wanted to have a standard. Their cathedrals had been built, and had been measured, but they never had a standard. So they went to King Henry and said, "What shall we do?" "What shall the standard be?" And he decreed that the length of his arm should be the standard. And the official yard made at that time is now in the tower of London, and that is our basis of measurement. You must have a basis for everything to measure by. Now here are the varieties I tried: redtop, orchard grass, English rye grass, Italian rye grass, meadow fescue, hard fescue, sheep fescue, crested dogs tail, meadow fox tail, Kentucky blue grass, yellow oat grass, awnless broom grass, perennial rye grass, creeping fescue, sweet

vernal grass, red, white, and scarlet clover, sanfoin. Now those were put out about fifteen years ago, and it was some years after that time before I began to find out what was what. I went on and examined this thing with care, and finally discovered this; I found the grasses had value for me in the order which I will now state. It is not enough that grass will grow. You want grasses which, after they grow, are worth something. A chemist will take a bunch of grass into his laboratory and, after putting it through a certain manipulation, will tell you what there is in it, but an old wether sheep will tell you a great deal better than a chemist. He beats the chemist. I am a believer in the idea that that which a sheep will eat in preference to something else is better than the other thing. It may not be so much this, that, or the other thing, but, depend upon it, that which the animals prefer they will do better upon. There are a great many things that never were dreamed of in the philosophy of a chemical laboratory, and among them is what effect this food or another has upon the intricate and complex organism of an animal when taken into the stomach and digested? I put my test of food value of grasses upon the animals feeding upon them. When I find one plot of grass eaten right down to the ground all the time I decide in favor of this one as against that. Now may be some of you will be surprised, but I put orchard grass at the head. Some will say it gets into bunches, and is a most worthless thing. Perhaps you will say you don't see how any man can recommend orchard grass for anything. "That is enough. I don't want to hear any more. I set him down. I know where he is right away." Let me tell you, orchard grass is the most valuable pasture grass in this world. I do not care what your experience with it in meadows has been. I say, as a pasture grass, it is a most valuable grass, and second to it is redtop.

Now let me stop right here. There is one other thing about grasses that I did not mention when I was talking about the kinds of growth, etc. Any of you who have ever held a plow know that there is a very great difference in the roots of different plants and grasses. There are some grasses that spread their roots right on the surface. Now timothy is a grass that can only grow to advantage under certain conditions of the atmosphere; that is, it must be a wet time. There must be sufficient moisture to keep the plant wet or moist or it cannot grow. That is timothy. But in redtop sod, or orchard grass,

you will find the roots running down deep. Why have they got that deep root? The English favorite, where it rains twenty-five or thirty days in every month of the year, does not need to send its roots down so far for moisture. I have seen in England a growth greater in ten days than a growth of six weeks in this country. All the roots are close to the top. Why? Because it is not necessary for it to take hold of the ground. The roots do not have to go down after moisture. The roots are all on the surface. They are nearer the surface than here, simply because the moisture is there, and the atmospheric conditions are favorable for that sort of thing. Therefore, timothy, and nearly all English grasses, have their roots running around on the surface. But you take our grasses and nearly every one sends its roots away down because we have had dry Julys, Augusts, and Septembers in this country for a great while, and they found out it was necessary. They said "We have got to have water, and if we have got to have water we have got to go where it is." They said "It is not up here, it's down below," and away their roots went down there to find it. What does that mean? It means that American grasses, as a rule, will grow during dry weather, or in a dry summer when European grasses will not grow at all. So we must bear all of these things in mind. First I put orchard grass, and second, redtop; third, crested dogs tail. Well, I don't know whether you love dogs or not. If you do not, then perhaps you have a prejudice against crested dogs tail. It is the most valuable English grass we can use in this country. It is used for the parks, and lawns around the country houses in England. As you may be aware, in England fine country places are laid out in this way. Here is the front of the house, and in this space before the house are trees and extensive stretches of grass first, and then forest. In the rear are the gardens for vegetables and flowers. In the park they have cattle and deer and sheep and horses pasturing all the year around. Also in this park, in front of the house, are beautifully kept lawns, especially if the family are there, and this crested dogs tail has been used for a great while for these grassy lawns because of its very brilliant color. It is the most brilliant colored grass you can find. It is called "Dogs Tail" because when it sends up its flower the flower looks like a crested tail. Another grass that I mentioned, meadow fox tail, is called fox tail because instead of the flower being like

the tail of a setter dog it is more like a round, compact cylinder, like a fox's tail, and that is what gives it its name. Now this grass I use, and I find there is nothing in that plat but crested dogs tail. All the other grass seeds have blown in there from every direction, and have fallen upon the plats and taken root there, but they are not equal to crested dogs tail. None of the rest of them have any chance. Sheep will come there and eat it, and prefer it. I have recommended this grass in different parts of the country. Among other things I recommended it for the golf club links of St. Andrew's Golf Club. They were having their links in Westchester seeded down, and it has been found to be just the thing for that purpose. It has come to be quite a fashionable grass for golf club links, and it has become so scarce that whereas I could buy the seed anywhere from twelve to fifteen cents it cannot be bought now for less than forty-five cents in England, and imported here in addition to that because the demand for it is so great.

Fourth, I put meadow fox tail. That is the first grass in the spring to grow. You will have the first bite for the animals of meadow fox tail in the spring when the other grasses are just beginning to grow. It will grow during April and May and then it takes a rest until September. In the autumn there is a most bountiful growth of meadow fox tail, and it is one of the most valuable of pasture grasses.

Fifth, I have here two varieties of fescues. There I stop. All others I have discarded, and there are enough, because I have included in that list varieties that will grow from the very first in the spring, as soon as the snow goes away, and come on in successive stages with fresh growth all through the season until winter sets in.

Now one thing more before I leave this question of permanent pastures. Be liberal with your pastures, and never over-feed. Never put too much stock on your pastures, and always put stock upon your pastures in such numbers that there will always be plenty of grass there. That is the secret. Do not put on so much stock that they will wipe out everything clear down to the ground for the sake of a little nibble of grass. The way to have pastures is to always have pasture. That is the way to have it. Protect your growth, and do not allow your stock to eat the growth clear down to the ground, for if you do, you are apt to have no more growth. If you have sufficient area for your stock, one time they will eat over here,

and another time over there, and in that way you have an abundance of pasture and feed, and the next spring, owing to the good heavy undergrowth, there is such protection that you will have pasture two or three weeks earlier than you would otherwise. That is the secret of having good pastures. It is in the treatment of your pastures. If you find that some portions of your pastures are becoming scanty, top dress them with manure. The best use of manure which can be made is that which the great farmer of nature uses in putting manure upon the surface of the soil. So much for pastures, and now as to the meadows.

What grasses shall we use for our meadows? I said that we find by experience that timothy and clover for a mixture make a very harmonious combination. That is the result of experience. There are other grasses which are good for that purpose. The orchard grass that you so much despise, perhaps, is one. I wonder whether there is a man in this room who has ever mowed his orchard grass at the right time? It is most always ready to cut and put into the barn by the 15th of June, and generally by the 10th. If you will cut your orchard grass then you will not have it growing in bunches. Now I am not going into this matter very much in regard to meadow grasses, because we cannot improve on the simple old combination of timothy and clover. But what I want to say is this: I think we cannot improve on that combination for value, but there is one thing we can improve on, and that is in using redtop with our timothy and clover. Why? Not specially for the value of the redtop, although that has food value. Most any chemist will tell you that it analyzes very high up indeed in its food value, as well as all the family of grasses to which redtop belongs. You have heard of what is known as "Rhode Island Bent Grass." That is a grass native to the islands of Narragansett Bay. It is called "Rhode Island Bent Grass" because it makes a bend in every joint. It is the finest lawn grass in America, because it sends out its leaves very close to the ground. Now timothy sends out leaves all along up the stalk, and if you will examine it you will see that there are no leaves down near the ground. Redtop sends out its leaves immediately over the ground occupied by the plant, and you cannot mow it so as to cut those leaves clear down. That is what makes it a lawn grass. It is the best in America, simply because you can mow it very

closely and there is still a great mass of leaves covering the ground. With these others that will not be the case. Now what is the great trouble with timothy? The little root from which the stalk grows, if it is exposed to the heat of the summer sun when we mow, if it is very hot, the vigor of that little bulb is lessened or entirely destroyed, and your timothy is killed. Timothy meadows run out because of the heat of the sun and drought following mowing in the summer before a new growth can be made to save the plant. Now if you sow redtop, when you cut your grass your timothy bulbs are protected by the leaves of the redtop which remain. Even if it had no food value itself it would be very desirable to grow redtop with the timothy, in order to prevent your timothy running out. With redtop your timothy will last two or three times as long, ordinarily, as it will without the redtop, and help to give permanent mowing land, which is the great object in our meadows. Under our old system we cut our hay and then in went the stock on to the meadows, and this grass which is set for the protection of the plants through the hot weather of August and September was all eaten off by the cattle, and the very thing which is of the utmost value for the protection of the plants we practically threw away by letting our cattle eat it up, and, of course, when the winter came on there was no protection for these timothy bulbs, and the frost got them, and those that it didn't get the next summer were exposed to the heat and drought and so were gradually killed out because they did not have the protection that nature designed that they should have. I wish we might never allow the foot of an animal to go on our meadows after mowing. Then there would be the greatest possible result. We must be liberal. We must be liberal with our stock, and we must be liberal with our plants. We should be as liberal with our grass plants as we are with tobacco plants if we expect to secure the greatest results. We have not protected them. We have not supplied them with their necessary winter covering, and that is why our meadows have run out; but if we will work along these natural rules our meadows will never lack grass, and we will secure the best returns.

To me this is a subject of very great interest, and if it is of sufficient interest to you to ask any questions upon it I will try

and answer them. Probably there will be some that I cannot answer, but I will answer any that I can.

The CHAIRMAN. There is one thing I am sure farmers have too little of, and that is music. Let us have some music.

[Music by the Orchestra.]

The CHAIRMAN. Now if there are any questions, let us have them. Most any man can ask questions, but it takes a wise man to answer them.

Mr. CHAMBERS. I would like to ask for the speaker's experience in top dressing, and whether he can recommend that for retaining timothy in his meadows year after year?

Col. WOOD. I have succeeded in retaining timothy with the treatment I have prescribed. I use top dressing. Treat your meadows so that the timothy will have shading in the hot, dry weather. That is necessary for its preservation. I have timothy meadows that I have been mowing right along, continuously for the past eighteen years, and they were never better than they are to-day.

Q. What time do you put on the dressing?

Col. WOOD. Oh, in the fall, and even later. I came away from home yesterday morning, and my teams were at work on two carloads of manure, hauling it out and putting it right on the surface. Of course I know some say it will blow away and wash away if it is put on now, but I believe that the best time to put out your manure is just as soon as it is made. Put it out now. It's there. You try it once and you will see it's there. Of course, for certain purposes you cannot put it out, and you have to pile it up, but you want to treat it in the best possible way in order to conserve its goodness and prevent waste. Fermentation is always accompanied by waste, but by judicious treatment you can minimize this waste, and the waste is much less by putting it out and taking the risk.

The CHAIRMAN. Do you think that putting this manure on the snow is better than putting it on after it has left?

Col. WOOD. Well, snow is a very curious article. When

a snowflake comes down through the air it does a good deal besides falling to the earth. You cannot wash clean with snow water. It is because the snow takes everything in the air as it comes along down. The water crystal contained in the snowflake takes free ammonia from the air. You cannot find a trace of free ammonia in the air after a snow storm. It is there in the snow. That is the only way in the world in which you can explain it, but it has been demonstrated over and over again. The vegetable matter in the soil prevents the waste of the free ammonia contained in the snow. That is the reason they say that "a snow storm in April is as good as a coat of manure." Because there is more free ammonia in the air at that time. Put your manure on broadcast when you have a place.

Q. How much seed ought we to sow for meadow and also for pasture?

Col. Wood. Well, that is rather of a difficult question to answer. I do not know as I can tell you all the figures from memory. It has been published in the *Country Gentleman* over and over again. Some of these seeds, as you know, come in the chaff. You cannot get clean seed of some varieties, because the seed is so fine that it cannot be separated from the chaff. Other seeds are heavy and can be cleaned. Crested dog's tail is heavy. It is like clover. I would not undertake to give you exact figures from memory, but I think in my practice for all seeds in the chaff I use from three to four bushels to the acre. It is blind business sowing seed in the chaff. Of crested dog's tail I put on ten pounds to the acre. Orchard grass that comes ordinarily in the chaff I put on at the rate of a bushel and a half to the acre. Be liberal in your treatment. If you are after a permanent pasture, treat it as an investment for a long time.

Q. I have been very much interested in the gentleman's remarks, and I would like to ask him what proportion of the hay crop he speaks of is timothy?

Col. Wood. Four-fifths of it. One-fifth of it is redtop.

There is not enough redtop in it to injure the sale of the hay. There is a good sale for the hay. There is a gentleman that lives in our village that keeps fine horses, and he is very particular about what kind of hay he feeds. He came to me one day and says: "Mr. Wood, I have no hay fit to feed my horses. It's all gone." "Well," I said, "my barns are all full, and I had to put out some stacks." I sold him some of that hay, and he told me that he never saw such hay in his life.

Mr. PLATT. I would like to inquire about the cultivation of orchard grass. I have known it to live for several generations where it was partially protected, but in ordinary ground and ordinary cultivation I never have seen it stand for any length of time.

Col. WOOD. I would say this: I have orchard grass for pastures that has been so for fifteen years. It is just as good to-day, and it has been there fifteen years.

Q. I would like to inquire whether it is a good plan to sow your redtop on the turf, particularly in the spring?

Col. WOOD. Without doubt. We have often heard the statement that the mowing machine killed the old meadows. That has been a very common thing. There are two reasons for that. The first is, the mowing machine cuts closer to the ground, and consequently there was not so much to shade the growth of the timothy. But the chief reason is, in the olden time, when they used to mow by hand, they let the grass attain a riper growth than we do now, and it ripened the seed so that in mowing it would shell out. So there you were, re-seeding every time you mowed. You can do that with timothy or almost any other grass. It is a good time to do that in the spring, and then run your harrow over it and scratch the land. Do it without plowing the ground.

Mr. MERWIN. I would like to ask Col. Wood if he regards raking as injurious to the grass?

Col. WOOD. I have often heard that stated, but I do not think there is anything in it. Too close raking might be injurious, but if you set your horse rake so that it just touches

the ground without scratching or tearing it I do not believe there is any injury. If the teeth of the rake are set in that position, just on a parallel with the surface of the ground, you do not injure it in the slightest degree.

Q. What is your opinion of plaster when sown on grass?

Col. WOOD. That is another deep question. Plaster has been very generally used, I know, but its only good, possibly, is to take ammonia from the air.

The CHAIRMAN. There is one thing we want to know in the meantime, while we are trying to rejuvenate these old rocky hillsides, and that is, how are we going to keep the bushes and briars from growing?

Col. WOOD. The first answer to that is, never let them be there.

The CHAIRMAN. But after they have got there. What shall we do?

Col. WOOD. We are met with a condition and not a theory. The condition is, they are there. It is a pretty difficult question to answer, yet there is a way to do it. Of course you can go to work and grub them out at a cost more than the land is worth. I will tell you what my observation has led me to believe after some little experience. The bushes, if they have been there some time, often grow up to a considerable size. You cannot get rid of them without cutting them close. The object is to get rid of the woody growth, and then they will sprout up the next year, and the best way to destroy that is to put the sheep at it. Put the sheep on to them. The new wire fencing has solved the sheep problem, both as to keeping the sheep in and dogs out. All animals of the deer family are fond of browsing. The deer lives by browsing, and the sheep has the same instinct, and browses not so much for the nourishment it gets as for the fun of the thing; hence, a sheep will almost break its neck to get over to some place where it can browse a little. I was just looking down there at Mr. Hale, and he reminds me of a story of the man who made some pure brandied peaches and sent a present of some

of them to a friend. The friend received the peaches and says: "I am very much obliged to you. I don't care a snap about your peaches, but I do appreciate the spirit in which they are sent." Now that is the way with sheep and bushes. They do not care about the browsing so much, but they do appreciate the spirit in which they are sent, and that is the fun they get out of them. When you cut your bushes, if sheep are there they will browse off the sprouts. I said a little while ago never to over-stock your pasture, but there are some conditions where you have to. So if you want to make your sheep eat down so close that nothing will grow again put on more sheep, and if you want to get rid of these bushes and sprouts, then put on more sheep, so they will not only browse for the fun of the thing, but they will browse for dinner. So over-stock with sheep and they will take care of your bushes.

Q. Is there any benefit in planting locust trees on the sidehills in this vicinity where they are not supplied with timber or cultivated?

Col. WOOD. Yes; the locust is a very peculiar tree. It has a rapid growth, and there is usually a great growth of grass under this tree. It attracts moisture, and there is a constant moisture about the tree such as no other tree furnishes, and it does benefit the land in that way. By planting locust trees you get a growth of a most valuable rapid growing timber, when the worms do not come in and destroy them, and you also get a growth of grass such as you would get under no other tree.

Q. You speak of foxtail grass in the pastures. Would you turn horses in there?

Col. WOOD. Yes; it does not hurt the foxtail at all to put the horses on. Horses are very fond of it. Sometimes it is desirable to let a horse run out all winter. There is nothing better for the rejuvenation of an old horse than plenty of green feed. I have turned some horses out, and when they found where the meadow foxtail made its growth they staid there all

the time. There is no better evidence in the world of the value of that grass for food purposes.

Q. Do you advise putting a roller on the meadow in the spring of the year?

Col. WOOD. It is a very good thing.

Dr. JENKINS. I think, Mr. Chairman, that the question concerning foxtail grass indicated that the two gentlemen are thinking of two different species. I think the foxtail referred to by the questioner is a different thing entirely from the meadow foxtail which Mr. Wood has been speaking about. It is a little mean grass, and the seeds are said to be very irritating when cattle eat them, but that, of course, has nothing to do with the meadow foxtail.

Col. WOOD. That is a native American grass, which is different from the meadow foxtail. The injury from that grass comes from the seed. It is said that sometimes a horse which has eaten it will break out with pimples, particularly under the collar. There is nothing of this from the English meadow foxtail.

The CHAIRMAN. Have you had any experience with sowing grass in cornfields?

Col. WOOD. Not on my own land. I have a farmer alongside of me that is a hustler. A few years ago he began the practice of sowing timothy and other grass seed in his corn at the last cultivation. I have been amazed at the result. I am not sure but it is one of the greatest practical advances in agriculture, and for this reason: We keep our land out of grass the least possible. It is a very good thing. Clover does splendidly, and so does timothy. So far as I see, it is a great success. I was patting my hustler of a neighbor on the back and telling him how magnificent this was, but one day he told my foreman, with a peculiar wink to his eye: "This part of the field I put a half a ton of extra fertilizer on, just for Mr. Wood to see the effect on this grass." I guess it paid him, if he did get the best of me.

Q. What do you do with the corn stubs?

Col. WOOD. That is a good question. When the ground is frozen hard, take a piece of railroad iron or track and go over it with that. I have got a length of railroad iron that I never dared to ask my foreman where he got it. I think he stole it from the railroad, but I would not ask him, because I do not want to have him tell me that. But it don't make any difference where he got it; when the ground freezes up he simply hitches on to that thing and drags it over the land at full length and it just knocks the stubble off as smooth and nice as you wish. He goes back and forth with that instrument and there is no corn stubble on the field. You want a tool of that kind. Don't steal it from the railroad, but get it some way, and then treat all your cornfields that way.

Sec. GOLD. Allow me to explain about Mr. Olcott's grass garden. He shows clearly the fact that many species of our common field grasses run into a great number of distinct varieties, as also does our Indian corn, which is a member of the grass family. All of these varieties readily hybridize or mix with each other. We have all varieties of shape and color in the kernel or seed, and in mature growth from one foot to twenty feet in height. So we are familiar with the varieties of wheat, oats, and other cereals, varieties of distinct species.

Mr. Olcott raises pure cultures of grass in his grass garden. The produce of a single seed is multiplied by taking little shoots from the mother plant and setting them in a bed at regular distances and keeping clear of all outsiders. So a bit of turf has been taken from an old English churchyard or lawn and a single root dissected and multiplied in the same way as was done with the seedling. Thus he has beds of remarkable evenness and similarity in color, size, and shape of every shoot and leaf. He does not allow any grasses or weeds to go to seed in his garden; all intruders in his beds are quickly detected by his practiced eye and exterminated. The lawn mower is in constant use, resulting in the product from his choicest varieties of an elastic turf to tread upon, a velvet carpet of the purest shades of green or blue or purple, as the

variety furnishes, often influenced by the season of the year. Some like heat and stand drouth, others start early and seem to defy frost, being almost evergreen.

Mr. Olcott in his researches has visited not only all parts of the United States, Australia, and many other islands of the Pacific, but all the famous grass sections of the British Islands and Continental Europe. Curious travelers to other parts of the globe have furnished specimens until Mr. Olcott's collection of living grasses surpasses that of any other in the world.

Some naturally form turf and others grow only in tufts or bunches and cannot be made to cover the ground. The common visitor is dazed with the variety of color and form, the student of grass, as a botanist, gets little satisfaction, for the plats are not allowed to throw up stalks and form seeds, but show just what each variety will do under the lawn mower or close pasturing, in furnishing an elastic, close, and enduring turf, that thrives under moderate tramping, the condition of a pleasure lawn, or a well-kept sheep pasture.

This work to which Mr. Olcott has been so devoted for many years, and to which he brings the observations of a lifetime of an acute student of nature, is under the patronage of the Connecticut Experiment Station. A moderate sum has been provided by the station for the support of this garden and for traveling expenses in prosecuting the work. It must be seen to be appreciated, and all are invited to visit Mr. Olcott's grass garden and see for themselves. The student of nature will rejoice to see one line of God's works so beautifully, so fully illustrated, while the grazier, the practical farmer, or the gardener must be a dullard who cannot get some ideas of value for his own use in his practical life work.

Col. Wood. I am delighted to know that these experiments are being conducted in your State. The result must be of exceeding value. I hope he will succeed, and that the encouragement to which he is entitled will be given him, but

you should see to it that while these scientific observations are being made records are kept that will be of value to the world.

Mr. PLATTS. I would like to ask one more question in regard to the treatment of mowing land. The pasturing of mowing land has been condemned. Would you or not cut off the after-growth at all? Or, if you are to cut it off at all, what is the particular difference between cutting it with a mower or grazing it with cattle?

Col. WOOD. The difference is this: Mowing is a great deal worse than grazing, yet I have frequently thought it best to mow a second crop on my timothy meadow. Now you may have too much of a good thing, and you may have too much grass on your land. If you have, and a great amount, is't in the way the next year, and it may be an injury to the next year's crop of grass or hay. Then it is better to mow it. I never have mowed it, though, without giving it a top-dressing of stable manure. What I am after is protection. Just so with plants, when the time comes to protect them from the winter for next spring and summer's pleasure, just so much you protect these plants out in the field for next spring and summer's pleasure. If you strip off the coat which nature has placed there for the protection of plant life through the winter months, then you must supply something in its place. When I mow my meadows a second time I see to it that before winter comes on they have protection which is sufficient.

Mr. PLATTS. I have sometimes left my after-growth, when I thought it was not too large, and anywhere within a few miles of the seashore we sometimes have as much ice, or more than we do snow. Now I have had grass smothered where there has been a good deal of after-growth, but I never saw a piece of grass that was reasonably protected, that is, not too much on, that ever was killed by ice, but I have known it repeatedly where there was quite a growth.

Col. WOOD. That is a thing that sometimes happens. The ice kills the plants by suffocation. The leaves of the plants are the lungs of the plant through which they breathe.

Now if the plant is so that it can breathe, the ice don't seem to hurt it. The plant is in a sort of dormant condition. But when you have plants that are entirely covered so they cannot breathe they winter-kill. This breathing is going on all winter, and if the plant is properly protected, and not suffocated so but what it can breathe, it comes through the winter all right, and comes out bright and fresh and vigorous in the spring.

Mr. PLATTS. In regard to my meadows, I hesitated a long time. I did not know whether I had better mow them a second time, or pasture, or let them go. I always said no pasturing of meadows, but this year there was too much grass, and the question was, what will I do with this surplus grass? It looked to me as if it would be terribly in the way next spring, and the suggestion occurred to me whether it would not be better to let it alone and burn it over next spring, so as to get that surplus grass out of the way. It will be too thick to mow with any comfort, and the old grass will be in the way of the new crop.

Col. WOOD. Sufficient unto the day is the evil thereof. The probabilities are that by next spring it will be so matted down it will be out of the way, and I venture to say that you will not find that in the way. Nature takes care of that, and puts that surplus grass down by the winter's snow so closely to the ground that it is only there to act as protection for the other plants. Now if you are going to burn that meadow over, that may be well, but leave it until pretty late. People like to burn over land. They are like the boys who want to get out and fly their kites. There is a great temptation to do it pretty early, but if you burn it over too early you will expose the plants to the frosts that will come along and kill the buds. That will do you ten times more damage than it will to let it be until a little later before you burn. Burn it over pretty late in the spring, when there is no more great danger from frost. It is a very intelligent suggestion you make in

regard to burning over, but it requires good judgment as to when it is applicable or not.

Mr. YALE. I am very glad to hear this matter discussed. Now I have been reading how much better it is not to pasture your meadows, but we have always pastured our meadows. I know of a tract of twenty-six acres that was pastured a year ago, soon after it was mowed, and it was the best twenty-six acres in our part of the country this year. You leave the after-growth there, and the next year it clogs up the machine, and it's a great nuisance. You pasture it awhile in the fall, and get rid of a little of that surplus growth, and let the cattle feed over it and spread their manure on it, and it's worth ten times as much to your grass as it is to burn it the next spring. Our experience with pasturing is that they will do just as well if they are not cropped down too close.

Sec. GOLD. In regard to pasturing meadows, I must say that I practice it, but I am careful not to turn the stock in until there is a good growth. We give them a chance to recuperate after they are mowed, and when it gets up big enough to mow again we turn the cattle in and they eat it, tread it down, and leave an abundance there to protect the next year's crop from winter-kill.

The CHAIRMAN. There is one little incident in connection with sowing redtop with timothy and clover I want to relate. I remember very well seeding down a piece of land, — it was one of my first experiences in sowing redtop, and that grass was the biggest that ever grew on my farm. It was right beside the highway, and I remember the time I had mowing that grass. It was so high that a person in the highway could not see my team.

Col. WOOD. I want to say that that is one of the President's stories, not mine.

The CHAIRMAN. I wanted to recommend sowing a little redtop. Somehow it works wonders. I was going to say that that crop I referred to was highly manured, and there was an enormous growth after I had mowed it, but in the spring I

had not a green thing there. It was smothered out completely. I imagine the ice smothered it out.

Sec. GOLD. We have now had Col. Wood here for over two hours, and he has certainly given us a great deal of information. I have arranged with the musicians to let me give my notices first, and then we will have some music and adjourn until afternoon. You will observe that the exercises for this afternoon have been seriously interfered with by the dispensation of Providence, and in place of the regular exercises upon our program as originally printed the time will be devoted to a memorial tribute to Col. Waring. We hope to begin our exercises at 2 o'clock, and, if there is time afterwards, agricultural matters will come up for discussion. We earnestly invite you to be present. I have the promise of some gentlemen to speak upon that subject, and I know that the time will not be wasted, even for an agricultural convention to take some notice of the life and sacrifices of Col. Waring.

[Music by the Orchestra.]

Convention adjourned until 2 o'clock.

AFTERNOON SESSION.

Wednesday, December 14, 1898.

Convention called to order at 2 P. M.

Sec. GOLD. You will notice that our program announces to you the special object for which we are met together this afternoon. You will appreciate my feelings when I say that while this program was in the printers' hands, and almost ready to be issued, I received the sad announcement of the death of our friend, Col. Waring. We all sympathize with his friends in this great loss, but you will see how peculiar were my relations and my situation on account of his death; and I thought it would be a most fitting thing to allow some of his friends to meet with us this afternoon and bear testimony of respect to his memory. I have some letters in my hands here which I will read in opening the exercises of the afternoon:

LETTER FROM HON. GEO. T. POWELL, GHENT, N. Y.

T. S. Gold, Secretary.

MY DEAR SIR:

Not being able to attend the session to be devoted to the memory of the lamented Col. Geo. E. Waring, I desire to send a word of tribute to his most useful and noble life.

The lives of all good men are what make the world better. Col. Waring's life endeared all men to him, not only for its goodness, but for its extreme usefulness.

All classes of citizens have been brought in touch with his inspiring life. All sections of our country have been benefited by his scientific knowledge, practically applied in so many ways, for the benefit, the pleasure, and the health of the people.

He had a high appreciation of the calling of agriculture. He saw much in the soil to call forth the powers of his active mind.

One of his early publications, "Elements of Agriculture," a book for young farmers, is one so full of instruction that none can read it without a feeling of greater love and respect for the earth, with its many hidden and mysterious treasures.

In his very valuable work, "Draining for Profit and Draining for Health," farmers have had helps in the improvement of their soil that are beyond computation in value.

It was while engaged in the management of a large farm in Rhode Island, where his best thought was given to the breeding and raising of superior animals, to the improvement of the soil, through his scientific study of the action of fertilizers, and of the value of underdraining, that Col. Waring gave to the world some of its best agricultural literature.

In no place has Col. Waring shown stronger character than when called to occupy positions of public trust. In these he has considered obligation to the public good of others as sacred as any private trust, and he has given to our country a splendid example of the value of political independence in the administration of public duties.

Every city in our great country is to-day a better place for its dwellers as the result of the successful efforts of Col. Waring in putting the great metropolis of our nation in a clean, healthful condition for the poor and rich alike. This Herculean task was accomplished by his loyalty and faithfulness to the interests and rights of his fellow citizens in the

honest expenditure of public funds, and no political demands could for a moment swerve him from the path of duty.

To young men who are rapidly coming upon the stage of active duty, the closer the life of Col. Waring is studied, and his virtues discovered and copied, the fuller will their lives be touched by inspiration, and from their faithfulness to a higher standard of private virtue and of public duty our country will be greatly blessed.

Very truly,

GEO. T. POWELL.

LETTER FROM DR. CHARLES A. LINDSLEY, NEW HAVEN.

T. S. Gold, Secretary Connecticut Board of Agriculture.

SIR: It is with a sense of sad satisfaction that I respond to your request for a few lines in tribute to the memory of my late friend, Col. George E. Waring, Jr.

It seems eminently appropriate and reflects honor upon your organization that as a body you should take this occasion to commemorate the virtues and manifest your respect for the exalted worth of one who began his life career of public, useful achievements as a practical agriculturist and lecturer on scientific farming, and whose interest in the calling, to which the members of your society are devoted, has never failed.

The patriotism of Col. Waring led him to enlist with characteristic enthusiasm in the war of the late rebellion, through which he served with valor and distinction. After the war he again returned to the pursuit of agriculture, devoting himself to the higher branches of the art from a scientific standpoint. He was soon recognized as an authority in all that pertains to the development of landed interests, including agricultural chemistry, engineering, stock-raising, etc.

Col. Waring has also won an enviable position in the literary world as an interesting and charming author.

But it is upon his many successful undertakings as a sanitary engineer that his fame and reputation will chiefly rest.

After Memphis had been almost utterly destroyed by that fearful epidemic of yellow fever which so nearly depopulated it that it was stated, in a public address delivered there soon after, that "so desperate and hopeless did its condition appear that the heartless and incendiary suggestion was offered, that the flames be made to consume what the pestilence had spared; and thus in one huge holocaust, Memphis, like its prototype

upon the Nile, should become a thing of the past." But, fortunately, better counsels prevailed. The engineering skill of Col. Waring was invoked, and he redeemed the city from the grossly unsanitary condition into which it had fallen, and raised it to the rank of the healthy cities of the land, by the introduction of a good water supply, and by giving the first large illustration of the "separate system" of sewerage in this country.

One of the strong features in Col. Waring's character was its practical side, his remarkable ability to utilize and apply his knowledge. He was a great organizer. As an executive officer he won the admiration of America when he so successfully executed the Herculean task of cleaning the streets of New York of the accumulated filth of many years of Tammany's mal-administrations. This was an achievement which was a conspicuous object lesson to the whole country, and contributed more to his popular fame than anything which he had previously done.

Above all, Col. Waring was a sanitarian. He knew that the cleansing of New York would be costly, and claimed the right to expend what was necessary. Almost all social reforms require large outlays of money, but if they are judicious they are also largely remunerative, as in this case, in the greater exemption which it has given New York from preventable diseases, and in establishing the reputation of the city for salubrity and safety.

But the crowning achievement of Col. Waring's life was its final sacrifice, in consequence of his patriotic exposure, to discover and devise the means of permanently removing the menace of the fearful yellow fever which has so often and so terribly afflicted the American coast, demonstrating at the same time, in his death, the instant danger of such menace.

The most enduring monument to Col. Waring's fame will be written on the historic page that tells the story of his part in expelling the pestilence from Havana and relieving the United States of so dangerous a neighbor.

C. A. LINDSLEY.

LETTER FROM PROF. W. E. SUMNER, NEW HAVEN.

What I admired most in Col. Waring was his zeal for his work and his administrative ability. He wrote well, and his literary productions about his specialty have permanent value, but when he got a chance he also proved that he could organize

work on the largest scale to carry out his ideas. This is a rare combination, and it was this combination which made him a very valuable man. It behooves every man to take to heart the fact that we could not employ such a man, in a way to get the full benefit of his services, in our municipal system. How much he could have accomplished if he had been employed in New York city for twenty or thirty years, so that he could have introduced routine and established traditions to maintain and secure what he had devised.

W. E. SUMNER.

LETTER FROM HON. THEODORE ROOSEVELT.

New York, December 7, 1898.

MY DEAR SIR:

Few men in recent years have rendered the country greater service than Col. Waring. His death was the greatest possible loss to this city and State.

Faithfully yours,

THEODORE ROOSEVELT.

Theodore S. Gold, Esq.,
West Cornwall, Conn.

MR. GOLD. That closes the letters that I have received. Now I will call upon Col. Wood to give you his testimony.

Col. WOOD. Mr. Chairman, Ladies, and Gentlemen: We devote this hour to a tribute of respect and appreciation to the great ability and high personal worth and distinguished personal service to the public of George E. Waring, Jr.

Forty-three years ago last September I first became acquainted with Colonel Waring. He was then the most magnificent specimen of youthful vigor and manly development I have ever seen. He had just come to the Greeley farm at Chautauqua, about five miles from where I resided, to take charge of that enterprise, of which Mr. Greeley knew so little, and about which Colonel Waring was destined to know so much. In September of the year 1855 he exhibited at the Westchester county fair, an agricultural fair, the implements he was using upon the Greeley farm. I first saw him hold of the handles of a plow that was turning a furrow ten inches deep and eighteen wide. My admiration was excited by the scene. He afterwards acknowledged that the theory upon which he was working was all wrong; that he was all in error

about that deep plowing, but that was one of the characteristics of the man. He had no pride to cause him to adhere to an error if he found he was wrong. His character was infinitely above that, and all he sought for was the truth.

He was born in the State of New York, just over the Connecticut line, but New York can scarcely claim any credit from his birth, because but a short time after his birth he came to Connecticut with his family, who moved to Stamford in this State, and he grew up a Connecticut boy. He went to school at Poughkeepsie on the Hudson River. Why his father sent him to this institution it is perhaps unnecessary for me to relate in detail, but there are some interesting circumstances why he selected that school and the appearance of those great qualities to which I have referred. He remained at Chautauqua until nearly the breaking out of the Civil War, and then he went to the war, serving in the cavalry branch of the service, and upon his return home published his first book upon "Drainage for Profit, Drainage for Health." His experience with Greeley determined his career, because it fixed his occupation. On that small farm was a swamp, one of those formations similar to what you have in Connecticut and all through this geological district, extending from western Massachusetts down, or nearly to the Narrows.

Originally there was a pocket in the hills, and around the margin great mosses grew. It was a great marshy, wet, low place, until in the process of time it was a sort of boggy formation, such as many of you know. Many unsuccessful efforts have been made to turn such land into good fields. When Waring went there he had not had a very large experience, and Mr. Greeley had not, but it was not long before Waring had acquired a large amount of experience, and Mr. Greeley had experienced a large amount of expense. After the water was taken away from this swamp it shrank, and pretty soon Colonel Waring found that the level of the swamp was below the level of his outlet, and then he found great difficulty, as his outlet was a river which flows into the Hudson, and he met with something that could not be controlled, as every freshet would set it back, obstructing the channel. Here he had to overcome one of the most troublesome problems of drainage. He did this work over three times, and when he had finished it the third time he was master of the art of drainage, and his life work was before him. His book

on drainage for profit and drainage for health is the standard upon that subject in the literature of this country and Great Britain.

His career went on from this to that, and from that to greater things, until his fame was world-wide. He went to the Ogden farm at Newport, R. I., and he wrote a delightful series of agricultural papers called the "Ogden Papers," which were published in the *American Agriculturist*, and which have not been surpassed by anyone upon such a topic. In literary style, in clearness of statement, in correctness of conclusion, they were the peer of anything ever written upon such matters. In attractiveness of matter and manner of presentation they are simply models of literature and accumulated knowledge.

It is not necessary for me to speak of the great things he has accomplished, like that of the drainage of the city of Memphis. That has been referred to in one of the letters which have been read. I wish, however, to state some things in regard to Colonel Waring's character as illustrated in occurrences while he was street commissioner of the city of New York, and I want to refer to one instance in particular, to which I was a party. Now, this is a sort of confession. Colonel Waring had announced to the public that appointments would only be made in his department in a certain order, and promotions would be made upon the ground of merit alone. There was a young man in whom I felt a very great interest. I knew he was a thoroughly capable fellow, and I knew that he was fully equal to any place they could put him in. I felt a great interest in him. I knew he had had great experience in controlling men, and in the accomplishment of work, and I wanted to get him a place. Colonel Waring had been my friend for forty years. He had been frequently at my house. He had consulted with me in matters about which he had been in some doubt and about which he knew I had some information, and our terms of acquaintance were those of intimacy. I went to him to get this young man a position in the department. What a cruel thing it was. I have been ashamed of it ever since, to put my friend to the test on the very position he had taken before the public in reference to his department service. I can see it to-day, but I didn't then. He said: "Mr. Wood, I cannot do it. If your friend will come in at the bottom of the ladder

and take a broom and sweep crossings, and if he shows ability he will be promoted, I can assure you. The official eye will be upon him, and his promotion will be as rapid as the circumstances will warrant, but I cannot appoint him unless he will do as the rest and start at the bottom of the ladder."

I can pay no greater tribute to Colonel Waring than that. I am ashamed of it now. I knew the man, and yet I asked him to make that appointment right in the face of his public position. That fact stands out in my memory as one of the crowning things in all my personal experience with him. One thing more. You know of Colonel Waring's patriotic devotion. He went to Havana to devise means for cleaning the city and stamping out the yellow fever. He knew its dangers. Scarcely a man in all this country knew its terrors as well as he did. From the lips of his wife I have heard the story. His wife was of German birth. She came of a strong, vigorous, German family, magnificent in their manly development, and she was like her family. When the yellow fever broke out in New Orleans this girl was taken sick and was carried away. She left her whole family behind her. When she was ready to go back from the hospital they told her, "Your father has died, your mother has died, your brother has died, and your sisters have died, and, while you have recovered from the yellow fever, you are left alone." So she was, and to think that Colonel Waring himself had to die with yellow fever and his wife be left a widow, and that daughter fatherless — that he had to perish of a disease, the terrors of which he knew almost better than any other man in this country, and yet it didn't daunt him when the call came. No; his courage was equal to any trial, and when he thought he could be of service to his country he went to Havana with alacrity, and with the same willingness that he would have gone to a festive occasion where he would have expected only joy. When he returned, you know the sad, sad story. You know what our country lost. You know what manhood on this earth lost, and how gladly we know that our State is contributing to his memory and his worth.

Now a contribution of \$100,000 is being made. Why is this? Colonel Waring died a poor man. What, you say, a street commissioner of the city of New York a poor man? Such a thing is unknown in history. It is impossible. Yes, my friends, it is impossible to anyone but Colonel Waring.

The opportunities he had in that position had no temptation to him. The slightest margin on a contract, how all these opportunities were open to him to take from the public treasury. I know it all. No, none of these things he did. He was above them all. It was because of his manly public virtue and, therefore, this fund is being subscribed, the income of which shall be paid to his wife and daughter so long as they shall live, and then a monument; think of the magnificence of it, a chair is to be established in Columbia University, to be called the Waring civic fund, with which to teach civic virtue and public services. It is a monument which will be a monument worthy of the immortal fame of him to whose memory it will be dedicated. It is well that the Connecticut Board of Agriculture should pay this tribute of respect to the worth and ability of one of your most distinguished sons.

Mr. GOLD. I now have the pleasure of introducing Mr. Charles Dudley Warner.

Mr. WARNER. It is very little that I can add to the beautiful tributes to the personal character and life of Colonel Waring, as contained in the letters which have been read. It is a very sad thing for me, for I knew Colonel Waring for many years, both in public and private life, to stand here by my own impulse and make this tribute to a man whom to know was to respect. To my mind the greatest loss of the Spanish-American war is the death of Colonel Waring. I think the heaviest cost we have paid so far is that.

Colonel Waring had two things that do not always go together; great scientific accuracy in the working of his mind, individual curiosity in the things of science, and a splendid administrative ability. They do not always go together, but he was as distinguished in one department as in the other. He had not only splendid organizing ability, splendid administrative ability, but he was absolutely fearless. The moral courage of the man was equal to his other qualities, and that does not often occur. His courage never was doubted in the field, and after he had had that experience in New York it was never doubted for an instant anywhere that he had supreme moral courage. He liked to fight. That is true. He rather enjoyed that little scrimmage in New York. I used to talk it over with him from time to time, and there

never was exactly such another test put upon any man. He was tried by many tests and found equal to the call. Colonel Wood has told you of one of those tests. When he came to New York, you remember he looked over the field for some time before he decided to accept the position of commissioner of streets, and it was not until he had obtained from the mayor absolute written security that he should have the administration of the office undisturbed, so far as any political interference was concerned, that he accepted the place. After he had accepted the place, however, he was in receipt from the best people of New York of a great deal of polite attention. He was invited to dinners, and was made very much of. After he had had a course of this he began to notice that he was called aside by one distinguished personage and another, the best men of the city of both parties, here and there, and little suggestions offered, and little questions asked him, and there had to be little appointments, and committees met. Waring turned a deaf ear to that for some time, until finally it became a little irksome to him. He found that he was expected to administer the office which he had come into from the reform administration of New York in the interest of the party that had put him in, and he finally said to a very distinguished gentleman: "Now I am from the country; I am a sort of a hayseed fellow, and I don't know very much about such affairs. I came up here to clean the streets, and I haven't any time to attend to anything else." Well, do you know, that was an original idea to them there. This was the first time that a street commissioner of the city of New York thought it was his business to clean the streets. It was so astonishing that the people let him alone. Well, you know how he was assailed. You know there was a great deal of that. All the prejudices of those opposed to him were brought to bear, and it was decided by a good many people of both sides that he was in the way. You remember that extraordinary movement which was made upon him by the Grand Army. Now the Grand Army was worthy of all consideration, but Colonel Waring, as Mr. Wood has said, was intent upon only one thing, and that was the organization of a perfect street cleaning department that would do the work. He did not propose to build it up by political influences or carry it down by political requests. He simply had that one object in view, and when he was unassailable in that position

there was an effort made to crush him out. At one time in the mayor's office, during that tremendous pressure, there were four hundred petitions on the mayor's desk for his removal, and they were from all over the country. Colonel Waring took occasion to look up some of those matters, and one of the letters of the chapter, or whatever it is called, that had been the first to move against him was in regard to a man whom it was claimed was a pensioner. Colonel Waring looked into his case a little, and he was. He was a pensioner. He had served his country. He was honorably or dishonorably retired, but he was getting his pension all the same. He found that this patriot, who was accusing Waring of being a traitor, and a coward in the war, a traitor to his party, and of being against the old soldiers, had enlisted at the beginning of the war, and had served six days in New York as a hostler, and was sent of his own account on an expedition to Washington in regard to the horses, and that was his record. There were several other interesting things that Colonel Waring looked up, but these things did not daunt him. Even the people got a little shaky. "Waring is spending too much money," "The outgo is too excessive," and all that sort of thing became the cry. And, after all, he was not benefiting his party any, and he was expensive.

But after awhile there came that tremendous storm in January. Not a blizzard, but there was a sufficient fall of snow which seemed to cover up all New York. Waring's department had been most carefully selected. He was a good judge of men, and he went about getting the brightest young fellows, and men of technical education, so that the department was all alive all over. And then came down that tremendous snow-storm, and they were rather in despair. They had spent a great deal of money. Waring told me afterwards, "I saw my chance." "I said to every head of departments to spend money like water. Don't stop for anything. Clean the streets." The day after, New York, for the first time in its experience, was clean. Even away down on the east side it was clean; north, and everywhere. The people were astonished. Absolutely astonished. The thing had been done. After that the opposition practically stopped, and it was not heard any more. Those who had been opposed to him said: "Well, he comes high, but we have got to have him." You see what he had done here

showed the two things I spoke of, scientific knowledge, clear-headed devotion to his purpose, and splendid administrative ability and grit. It was good American grit. He hung on, and that is what made Waring the big man he was. He was absolutely fearless about refusing anybody or anything that interfered with his public duty. Waring did not reply to his accusers. He went ahead and cleaned the streets. He did that and nothing more. And that, as one of these letters suggests, that example of the execution of law, and of fidelity to his public duty, and of actually doing the thing which he set out to do, has been of incalculable service to this country. Even here in Hartford I see it. He showed that if a man has force, and is legally minded to enforce the law, this country would actually submit to him the enforcement of law. This was one of the great lessons of Waring's life.

Sec. GOLD. Now we want to hear from one of our Connecticut farmers on this subject. The Hon. William E. Simonds.

Mr. SIMONDS. Mr. President, and Gentlemen: When I arise before an audience of any sort and take a paper out of my pocket it is a sure sign that I have not had time to prepare myself to make the remarks which I desire, and which I think are appropriate. I have enjoyed very much hearing what Colonel Waring has done, but I have to say that when a man interests me, and a great many men do interest me, I am more interested in what he is than in what he has done or does. I am interested in what he does, because it is evidence of what kind of man he is. Now I did not have the pleasure of an intimate friendship with Colonel Waring, such as Colonel Wood and Mr. Warner enjoyed, and which I, also, would have enjoyed, and what few words I have to say are mainly those of an observer. And perhaps a few words from that point of view, some things which seem to supplement what has been said by these two evidently valued friends of Colonel Waring's, may be of interest.

Something like twenty-five years ago, more or less, and I think it was more, it fell to my lot to prosecute to completion an application or applications for patents on certain sanitary appliances in Colonel Waring's behalf. My acquaintance with the Colonel began in that way, and at that time. During the prosecution of these applications there was a differ-

ence of opinion, which became rather marked, between Colonel Waring and myself, but it was finally adjusted to the satisfaction of both of us. In the adjustment of that difference, Colonel Waring's letters carried with them such an air of candor and fairness that it called my attention particularly to him at that time, and in consequence of that I have ever since then watched his career as it has been given in the public press, and sometimes by the mouths of those who were his friends. Now I came to have then, and afterwards, a certain opinion about him, and the directions which he gave with reference to the disposal of his body, and what should be done at the time of his funeral, as reported in the public press, seemed to confirm my belief that my opinion of him was correct. I do not think there is any doubt but that he was an ambitious man. Anyone who supposes that a man who comes before the public with his personal effort is not ambitious is mistaken. In doing this, such a man is largely influenced by ambition. Perhaps Tennyson and Lincoln have been written about as regards their modesty as much as, or more than, any other two men of great eminence, but let nobody make the mistake to think that there was not a deep and strong ambition moving in both of these men which led them before the public eye to the extent they went. Ambitions differ, not only as regards their nature, but as regards the influences which modify them contained in the person in question. Mere notoriety is as hateful a thing as can be to a man who is properly constituted. Any ambition worth the name is one that desires reputation for doing some worthy thing. That kind of ambition Colonel Waring had in plenty. Such an ambition as this is consistent with modesty in its purest essence. And such modesty Colonel Waring had in plenty, also. He was more or less in the public eye for the greater part of his life, but he never sought any advertising by meretricious methods. He was content to put forth the best effort and work that was in him and there let the matter rest. If such work and energy did not bring the reward he sought, he was quite willing to abide by the result.

Colonel Waring had a quality of courage which is exceedingly rare in this world. So far as mere physical courage is concerned, he demonstrated his possession of that most amply by his service in the War of the Rebellion. But I am referring just now to quite a different sort of courage. You

may not all have noticed that when he was about to die he desired, if I am rightly informed, that there should be no funeral services over his remains. Having some occasion, from certain personal appearances, to know that he was an exceedingly reverent man, one naturally seeks to reconcile the two facts. Now it would not surprise me to know that for every waking hour of his life Colonel Waring appealed to Almighty God in his thoughts. Alongside of that it would not surprise me to know that, while he had a charity for every possible kind of religious belief, he felt that he, himself, knew far too little about eternal verities to tie himself up to any dogmas or any creeds. I have an idea that Colonel Waring went down to his grave with entire serenity, in undoubting faith and courage that the Ruler of the Universe would deal rightly and justly with him, not for any special reason, but as a matter of course. Now that, to my mind, is a very high order of courage, indeed, and perhaps the highest known to this world. Having this sort of courage, Colonel Waring knew no fear of man whatsoever. He did his duty, wherever he found it, with every ounce of force and energy that was in him, hoping to accomplish such things as would make him of good repute among his brother men, but hoping, first of all, to merit the approbation of Almighty God, and content, after he had done this, to let the issue remain with him.

It is possible, but not at all probable, that I have misunderstood George E. Waring. My attention was called to him very strongly when I first made his acquaintance, as I have stated. I have observed him as carefully as I could ever since, and the things which occurred at his death seemed to me to put a seal upon this belief of mine in his character. Doubtless there are other ways in which men may express a very high quality of character indeed, but I believe this to have been his way, and I am pleased to lay alongside of his memory a tribute of the highest respect of which I am capable.

Sec. GOLD. We should fail of our privilege if we failed to call upon another person who is present with us, a clergyman, to give brief testimony to Colonel Waring. The Rev. Dr. Twichell.

Dr. TWICHELL. Mr. President, I told Mr. Gold that I would heartily give my time to my friend, Mr. Warner, in

order that he might have a little more liberty than he would have had if he had been confined to a very short space of time.

I heard a thing of Colonel Waring the other day that touched me deeply, and it seemed to me a very significant incident. It was three or four winters ago, after the snow had arrived, when the east side of the city had not as yet come under the benefit of his hand, and when he was just beginning his work. It was all slush on the street pavements. He saw some children going to school, wading through that slush, and he noticed that none of them had any rubbers. He says: "I will make this street so clean and dry they won't need any rubbers." Now that indicated the kind of heart there was within him. He felt for people, and he felt for all people, without regard to condition. He had compassion and sympathy, and it was that inherent kindness in the man that drew men to him. That incident showed that he had the sentiment of good will towards men in him. It was ingrained in his character; it worked in him, and helped to give effect to the rest of it. Somehow or other the impression has gone out that he was a good man. And when the word came that he was dead, not alone did he die a death of martyrdom in order to help free Cuba from a dread disease, but there was this impression back of that which had gone out that he was a good man. It is a good thing. I believe that that impression of the quality of goodness in him, and the charity in his substance, is what is going to make his life overflow in time to come with usefulness and influence. The effect of such a life will be very great. Many young men will gather inspiration from his career, and start out in life with the determination to be of some account in their day and generation because of their service to the public. They look upon him as a man who was in the public service because he liked the public service, and because he saw therein an opportunity for high usefulness. He was not on the make. The curtain falls, and at once the people returning from the scene of his martyrdom began to say: "There must be a memorial. What shall it be?" Well, what memorial could there be to Colonel Waring except some institution, or work of Christian benevolence? Every other memorial would be inappropriate and unfitting. And so it was agreed that there shall be created a school or college, the light of which will radiate to that dark country, the scene where he laid down his life. Colonel

Waring died, and the thought of what should be done in his memory came up, and for his family that had been left poor. His own character suggested that it must be a benefit to the public. It was a dreadful loss, but he has left a seed, and that seed is going to multiply. The reflections suggested by the death of Colonel Waring have undoubtedly caused hundreds and thousands of young men who were looking that way to come to a consummation, to a ripening of a previous resolution to live that worthy kind of a life that he lived. His name is, and always will be, a name of inspiration, and we may thank God for it.

Sec. GOLD. We have with us a Massachusetts farmer, and I venture to call upon Mr. Hadwen of Worcester, Mass., to add his tribute upon this occasion.

Mr. HADWEN. Mr. Chairman, and Gentlemen: It seems to me it is hardly proper for the Chair to call upon one who has spent more than half a century in the sturdy toil of the farm to follow the speakers which you have heard here this afternoon. While I fully appreciate and love the kindly words that have been spoken of Mr. Waring, I have not had the pleasure of his personal acquaintance. I used, in earlier times, to read of his agricultural experiences, especially on the Ogden Farm, and I was profited thereby. I feel this country has sustained a great loss in his death. *It will be very hard to find a substitute* to fill his place for a long time to come. Of course the principles of modern street cleaning in our great cities are far beyond the comprehension of an ordinary farmer; therefore, I cannot say anything upon that subject, but I believe that the life of Colonel Waring has raised to a certain extent the farmers of the whole country. It has filled us with interest at this time, and he has taught the farmers principles which they will long remember, and which will prove of great benefit to their occupation.

Sec. GOLD. We hope that the audience will have an opportunity to hear from some others upon this occasion. We have a farmer right here from the State House. Mr. Hinman. We would like to hear from him.

Mr. HINMAN. Mr. Chairman, and Ladies and Gentlemen: Like my friend on my left (Mr. Hadwen), I never

knew Colonel Waring. He has been eulogized sufficiently, but if I may be pardoned I would like to say one thing upon the subject that he was to discuss, although I am by no means certain that my ground will be the ground that he would have taken had he been here. I believe that nature's laws are the laws of God. I read in a paper that according to the rate of annual decrease in proportion to the wheat growth of this country, or of the world, and the increase of population, it would be but a very few years before the wheat would be inadequate to feed the people of the world. If that is so it comes about through a failure to properly observe a natural law. Now this whole question of the disposal of sewage is only a broader application of the same thing, and it is going to result, in a few years, in serious difficulty unless the few simple natural laws that lay at the bottom of the solution of the trouble are obeyed. Now you take a fever germ; I do not care whether it is yellow fever or typhoid fever, and you put it into water, it multiplies and becomes a deadly poison; but you keep it out of water and it perishes. It is nature's punishment for violation of her law that water shall be kept pure, and in allowing our streams to be polluted, and the sewage of our cities to be a nuisance, we are simply allowing something that we ought not to do. I believe this fully, and I trust that the next Governor, in his annual message, will call attention to the fact that we should compel our soldiers down at Niantic to have their sinks where they cannot pollute the water if they are to have them at all. There they are in gravelly soil, within a short distance of wells, in some instances. The Governor should call upon the people of this State, and the next General Assembly, to provide for water there from outside, and further than that, there should be no sinks. That ground should be policed. If I lived within a reasonable distance of Niantic camp ground I would undertake, without expense to the State, to police those grounds every morning before the camp was up, and the grounds that I had would bear evidence of the fact that I was obeying the law of God and putting the waste where it belongs.

Years ago, when I was a boy, our house was filled with typhoid fever year after year. Of course the people in the neighborhood thought there was some reason, and the men in the neighborhood got together and cut down a pine tree that grew near the room that my father and mother occupied.

They laid the sickness to that pine tree. As a matter of fact, there was a vault within fifty feet of the well. The water was cold and as clear as crystal, and apparently as pure as could be, but that house was filled with typhoid fever until that vault was filled up, and then the whole thing changed, and now there has not been for the last forty years a case of typhoid fever in that house. Cutting down the pine tree had no effect whatever, but purifying the surroundings had just the effect needed. Now I say to you, and I say to anybody, that there is no possible way of disposing of your waste like putting it right on the soil, which will get the benefit of it. Now what Colonel Waring would have said upon this subject, of course, I do not know, but I believe he would have left a message on the line which I have given you. If the ashes and waste could be put together and form a compost so as to be taken back on the farms where it is needed, it would help very largely to solve this garbage question, and it is just exactly what our farms must have in the near future if the next generation is going to have anything to live on.

The CHAIRMAN. One thought has come to my mind. Had Colonel Waring been present with us to-day he could not have spoken to as many people, and he could not have spoken so effectively, as he will speak now. The sentiments connected with his life are going to be published, and every thought and purpose of his life is going to have a wider force and a more extensive influence, and the practical lesson of his life is going to penetrate everywhere.

Mr. HALE. In my early boyhood I recollect very well reading the Ogden Farm papers. In fact, all the agricultural literature that I read at that time was papers in that connection, and I was more than interested in them, and greatly pleased on my first trip to New York, as a boy, upon going to the office of the *Agriculturist*, to find Colonel Waring there, and being introduced to him. I feel it was a very great privilege. I remember he asked me as to my ambition, and I told him I expected to be a Connecticut farmer. He says: "If you are, if you have made up your mind, stick to it and you will win." I never have seen him since. I have always fol-

lowed the works of the man, and was more than rejoiced when he took up the position he did in New York city, as it was one of the things that he impressed on my mind. That was the thing he wanted to impress upon me in my boyhood, "Stick to it and you will win." I think that was inborn in the man, and I thought at the time he would win in New York, and he surely did.

Mr. ———. It can be seen what Mayor Strong of New York thought of him. He signed his name, and headed the subscription to the memorial fund with \$5,000.

Mr. KIRKHAM. I want to second what Mr. Hinman has said. I have taken a great interest in this question of the disposal of sewage, and about ten years ago I wanted to know what Colonel Waring thought about it, and I wrote to a friend of his concerning it, and he sent me a paper that Colonel Waring had written. I have never seen any other copy. His idea of the disposal of sewage agreed very closely with what Mr. Hinman has stated. I think if he had been here he would have covered the subject in about that way, and his statements would have been in accordance with what Mr. Hinman has said. There is no other reasonable thing that he could have done.

Sec. GOLD. The question has been asked me, "Did you know Colonel Waring?" I had the pleasure, in 1857, of spending a week in close and intimate connection with Colonel Waring, as members of a committee gathered from all parts of the country, at a trial of reapers and mowers by the United States Agricultural Society. My acquaintance began there. Since then I have not had the opportunity of close personal acquaintance, but I have had an interest in the man and his work from that time until this. A few years after that I was in Newport. He was at the time in charge of the Ogden Farm. He was the only man that I cared to see, and I called at his place of business for that purpose, but, unfortunately, I did not have an opportunity to meet him.

Being well satisfied that no one could give us better practical information upon the subject of sanitation, Colonel Waring was engaged early in the summer to give a lecture on the "Disposal of Garbage and Sewage in City and Country." All our people are dependent for life and health upon the universal prevalence of knowledge upon these topics.

Now I wish every one in this audience might have the opportunity to give hearty assent, which I am sure they feel, to the opinions that our speakers have expressed with regard to his works and worth, to the exalted life and spirit of Colonel Waring. Please say Amen.

The AUDIENCE. Amen.

QUESTION-BOX.

Mr. GOLD. There is some material in the question-box to which I call your attention.

Q. My Burbank plums rot badly. What can I do to remedy the trouble?

Mr. HALE. First, thin them out. They say that no plum should touch any other plum; and then spray them with Bordeaux.

Q. Do you advise then to keep on spraying?

Mr. HALE. No; unless you are pretty careful about it. I would not spray with full strength; reduce the solution.

Mr. GOLD. Are cement stable floors practicable? If so, how should they be constructed?

Mr. IVES. Yes sir, they are practicable. I built some seventeen or eighteen years ago, and they are good to-day. They do not cost so much to keep clean. They are more economical, because more durable, and they will stand acid. There is no better cow stable floor than that laid with cement.

Mr. GOLD. Anyone else got anything to say on that question?

Mr. ———. I think a cement floor is too cold in the winter season. There is not an inch of ground under my barn

that is not covered with cement, but on top of that, where the cows and horses stand, there is a plank flooring which can be moved readily and put back again if I wish to do so. The drainage is so arranged that there is no soaking into the earth at all. I think that cement floors are economical for a stable, and are valuable, but for my part I think that they are too cold for milch cows to lay upon while they are giving milk.

Mr. HUTCHINS. I will say that if you have plenty of bedding of good buckwheat straw, or chaff, or something of that sort, it does away with a good part of the coldness.

Q. I would like to ask how you fasten the plank in a stall laid with cement.

Mr. IVES. The planks are laid lengthwise as the cow stands, and they are fastened by just placing them under the sill that holds the front part of the manger. They can be slid right out and turned the other end first, or you can take those that are in the middle of the stall and put on the outside so that they will all wear evenly. The plank are not laid directly on the cement. There is a little scantling between. If you wish, you can fasten the rear end of the plank to the scantling.

Mr. SEELEY. I think I have something better for cows to stand on. First put your sill along at the front and then put two others back of that, so they will be sixteen or eighteen inches apart, so the cows will not trip. You can take any stick of timber and flatten it on one side to put down. Then between these and the after part of the cow fill in with dirt. Dig the drainage a little deeper and cover that with cobble stone work, well pounded down smooth and hard, and so it will be all solid. Put on a little straw, or any refuse, and your cow's knees will not be all worn off, and the arrangement will keep them clean and dry.

Mr. HADWEN. In speaking of stable floors, my cow stable floors are made of concrete. It is all concrete in the whole building. The flooring between the cattle and the stable

that the cattle stand in, is all concrete, so you can wash it out with water and thoroughly cleanse the place. Where the cattle stand I place some plank with a bed of leaves, which I can vary according to the season, so that the floor is both warm and cool through the seasons. I use leaves most altogether, as they not only prove of great benefit to the stock, but they also are of benefit to the excrement that goes into the receptacle for the manure. I think it is a great improvement to put in cement or concrete and to have planking for the cattle. It is more satisfactory to them, and the planks will hold the leaves better than a smooth floor of cement.

Mr. ———. I have had some trouble, and others I know have, with cows having large bunches on their knees, and I would like to know of a cure.

Mr. GOLD. Some stimulating liniment put upon these bunches will cause the absorption of the watery matter, but the general advice of physicians and veterinarians that I have consulted has been to let them alone and no harm will come. Do not try to tap them, or meddle with them in that kind of a way, but let them alone. They are unsightly, but not dangerous. Mr. Hadwen, have you had any experience in this matter?

Mr. HADWEN. In relation to bunches on cattle's knees, they are usually caused by slipping in reaching out for their food. They are liable to occur, but if you can place their food so they will not have to crowd forward and render them liable to slip you can remedy the evil, and I think the prevention is better than the cure.

Mr. GOLD. We have a horse stable which has a cement floor over the whole of it, but where the horses stand the cement is covered with scantling four inches wide and about three inches thick. They are reasonably close to each other, about half an inch or so between them, in order to facilitate drainage from the horse stall to the rear. Occasionally with an iron wire or poker, or some such instrument, any obstruc-

tions in these channels between the plank can be cleaned out, and the horse stands upon a perfectly dry plank floor with proper litter upon it.

Mr. HADWEN. My horse stalls are constructed in that manner. And I have an instrument that I draw through the spaces between the planking, and they are cleaned in that way. The planking comes together within about half an inch, and it is a very easy matter to keep the spaces clean and the stable perfectly sweet.

The CHAIRMAN. Anyone else on this question of cement floors? It is an important question.

Mr. HUTCHINS. I had an idea of how I ought to build this floor before I asked the question, but I thought I would bring it up, and if anybody was aware of anything new it would be brought out, and I would perhaps learn more than I would in any other way. I thought of putting a stone curbing behind this floor, and then filling up the space at least eighteen inches deep with cobble stone, and putting my cement on top of it. I do not wish to build this room but once, and I want to build it thoroughly the first time.

Mr. GOLD. "What is the matter with the strawberry market?" Mr. Hale is here, so I will call on him to answer that question.

Mr. HALE. Well, are you speaking of next season, or last season? I do not think at the present time the market is overstocked. I think if a man has any good berries to offer they will bring fairly remunerative prices. If you refer to last season, why, our New England market went all to pieces. There was a rainy season all up and down the Atlantic coast during the strawberry ripening period of '98, and there was a tremendous crop from Charlestown, N. C., to Nova Scotia, and the markets were abundantly supplied through the month of May from the far South. At the same time, our native strawberries ripened very nearly with those of New Jersey, and almost before the Delaware berries were gone, and the

consequence was there was a tremendous overloading of our market at that time. There was a greater crop than there has been in the eastern section of the United States for some time. I know they were sold very low, and a good many growers became discouraged, and a good many new beds were neglected. I do not think we shall see any repetition of last season's experience for a number of years to come.

Sec. GOLD. "In spraying fruit trees and vines, when can we spray intermittently, and when must we spray annually?"

Sec. GOLD. My opinion is that we should spray annually. If you are going to intermit, you may intermit just at the time when spraying will be the most necessary. There are some seasons when spraying is of comparatively little importance, and often when it did not seem to be necessary at all, yet the crop was better upon sprayed trees. A healthy foliage results in an abundant fruitage, and a healthy fruitage, and when there is only a moderate demand for spraying it shows that it does affect the quality of the fruit. Would you consider it safe to intermit spraying for a year on a vineyard, Mr. Hale?

Mr. HALE. No, sir. I would not. If you are going to begin at all, you have got to keep at it. It costs too much to begin, and know how to intermit.

Sec. GOLD. "What kind of a greenhouse is best situated for winter growing tomatoes, and what variety is best for table use?" The gentlemen who raised those tomatoes in the other room are better qualified to answer that than anyone I see here.

Mr. SHERWOOD. I never have had any experience in growing tomatoes, but I would say, however, so far as I can, that a tomato house should be about the temperature of a rose house.

Sec. GOLD. "What shall we do when we receive from the nurserymen trees having root galls on them?" What do you think about that, Mr. Hoyt?

Mr. HOYT. What do you mean by that? What are they?

Sec. GOLD. Well, sometimes you will get a tree with galls on the roots as big as walnuts, and sometimes smaller ones as big as hazelnuts, and sometimes smaller still strung on around the roots. Now if they are anywhere near the main body of the tree, I should not want to spend any more time with that tree, even if it did come from a nurseryman.

Mr. HOYT. I didn't understand. I should throw that tree away and buy of some nurseryman that did not cultivate that kind of trees.

Mr. SEELEY. I never saw but one instance of this description. It was called the ground knot. I saw some trees that came from a New Jersey nurseryman, and among them were quite a number that the owner showed me that had this swelling or enlargement near the root, which involved, in some cases, the whole of the body around. He told me it was a disease called the "ground knot." I had never heard of it before. I saw a sample of it in the back room.

Sec. GOLD. We have had that "ground knot" up before. What do you do, Mr. Hale, when you come across any trees with that on?

Mr. HALE. You will see them occasionally on peach and plum trees. If I saw it before the tree was planted I should throw it away, although sometimes a little knot may be cut away and the tree will grow all right.

Mr. HOLLISTER. In cases of root gall, if it can be done without mangling the tree too much, I should take a sharp knife and cut it all off. Cut it all off smooth. It will not decay.

Sec. GOLD. "Where trolley lines run on our country roads, which place suits the farmer best, to have the tracks in the center of the road or on one side?"

Mr. HALE. When our trolley line came over the east side six or seven years ago it was left to the selectmen to locate the layout, and there was a general uprising on the part of a good many people at the location. Of course some wanted it

where the other fellow did not. So, in most of the places, it went in the middle of the road. A few of us watched its operation for awhile and finally came to the conclusion that it was far better to have it one side or the other, and it was placed on my side of the road. If you can get a trolley to come by your house, get it on your side of the road, provided the other fellow don't want it, but get it to go on one side of the road and not in the middle. If it will go on your side of the road, so much the better. Get the road, anyway, and get it on your side if you can. If it's in the middle, you have got to wade through the mud of muddy streets to reach the car, and dodge teams, and it is a great deal more convenient on a muddy day to take your car right at your door than to go out into the middle of a muddy street. If they run in the middle of the road, in some narrow places there will not be room for the wheels of wagons between the tracks and the roadsides, while if the track is placed at the side there is almost always sufficient room for a wagon road of good width left. Don't let them destroy your trees.

Mr. HOTT. My experience leads me to say that I should insist that trolley tracks should be put on the side of the road. Some of the roads in Norwalk are almost ruined because they have got the tracks in the middle, and the street is not wide enough for the convenience of travel, whereas it would be if it was on one side.

Sec. GOLD. "What shall I do? I had a field of eight acres in corn and potatoes the past season, most of it plowed and covered with yard manure. I was intending to have seeded it down, but circumstances prevented. If I seed with oats in the spring they will probably lodge by the time they are half grown. What shall I do with it?"

Sec. GOLD. In answer to that, I should say we should put in application something we heard this morning. The question was asked me if I should derive any practical instruction from that lecture which I could put in practice upon my farm.

I could not say what particular point I was going to apply. There were a good many ideas that we might profitably employ, and I should apply one of them to this case; that he better seed that down next spring without any oats. Col. Wood has told us that it is much better than it is to exhaust the land with a grain crop.

Mr. SEELEY. I should tell that man to sow his oats, and put in his grass seed. If the crop of oats is liable to fall down, mow them and put them into the barn for hay. Your grass seed will do just as well under these conditions. Sow your grass seed, your timothy, or whatever it is, but by all means put in a little redtop. I don't want the man that asked that question to take what Mr. Seeley says, or what anybody else says, without thinking for himself, and using common sense.

Q. I would like to ask a question, — if anyone has been troubled with insects destroying their asparagus. They arrive in swarms and cut it off. Now is there any way of destroying them without destroying the asparagus?

Sec. GOLD. We are assured that a pretty thorough treatment with paris green after the time of cutting, if it did not help that season, it would promote a hearty growth and put your bed in pretty good condition for escaping next year.

Please remember the question box, and have it stocked up again for another day.

Convention adjourned until 7.30 P. M.

EVENING SESSION.

Wednesday, December 14, 1898.

Convention called to order at 7.30 P. M.

Sec. GOLD. I take pleasure in announcing to the audience that our friend, Mr. O. P. Hadwen, of Worcester, Mass., will act as our Chairman this evening.

Mr. HADWEN. Ladies and Gentlemen: I have been asked to preside at your convention this evening, and it is so unexpected to me that I hardly feel equal to the occasion, but

as a plain, common farmer I will do the best I can. The first subject this evening is "Common Sense Farming," and I have the pleasure of introducing Mr. R. S. Hinman of Oxford, Conn.

COMMON SENSE FARMING.

BY MR. R. S. HINMAN OF OXFORD, CONN.

Mr. Chairman, Ladies and Gentlemen: I hardly think anyone who has attended a farmers' convention in Connecticut within the past twenty years will expect me to lay down any iron-clad rules as to what is common sense as applied to the management of a farm.

If I were asked as to which showed the most common sense, the master of a coasting sloop carrying oysters, potatoes, or cabbages from one point to another along the coast, or the owner of a yacht that he used during the few months in summer for cruising to the same or other points, I should answer that both were level-headed. The one sails his boat for a livelihood, the other for pleasure, and so long as each gets what he seeks both are equally sensible.

In Connecticut, farming differs quite as greatly, and in the consideration of the subject in a Connecticut farmers' convention we must take into account these differences.

To the man who has a farm to pay for and a family to support, the question as to what is to be done in the way of improvement as to fences, buildings, and the clearing of land from rocks and brush becomes an economical problem only. I have cleared a field of stones weighing from one to five hundred pounds that had interfered with tillage for a century. One of these stones that was the single interference with a plow or mowing machine in some two or three acres I removed by putting a chain around it and hitching it to the tail end of a cart. I do not think my predecessors in the proprietorship of that land showed good sense in leaving that nuisance there for generations. On the other hand I think I showed good common sense in hindering the team for ten minutes to remove it. I have a neighbor that removed a single rock by blasting from an acre of land that was not worth fifteen dollars, and the expense of its removal was not much or any less than that. 'At first thought you will say that man did not show good common sense, but there I differ with you. He is farming on the

yacht plan. He did not want more land, but he did want what he had to look nice, and the rock was an eye-sore and a source of discomfort to him. He could afford to remove it, and showed good sense in doing so.

In a general way the farmer should follow his own tastes and inclinations. Said a friend of mine, as we were riding together on a railroad train a few days ago, "The days of profitable dairying in Connecticut have passed, and farmers should turn their attention to fruit-growing." He may be right, but possibly if all the dairymen in Connecticut were to engage in fruit-growing, some of them might discover a few years later that there was money in milk, butter, and cheese. It is not every man that is qualified to grow fruit, and while the gentleman that I speak of may derive much greater profit from fruit-growing than from dairying, it does not follow that his next neighbor can. Some of the best land for pasturing cows in Connecticut is so situated or so constituted that it would be idiotic to attempt to grow any kind of fruit on it. The man that keeps a good herd of dairy cows may show just as much common sense as the fruit-grower. If they could change farms and temperaments it might be different, but, notwithstanding my friend's statement that the day of profitable dairying in Connecticut is past, I still think there are many sensible men engaged in the dairy business in Connecticut.

It does not follow that the most sensible farmer should be so egotistical as to think he knows it all, and it is equally certain that he cannot take the advice of every man he meets or follow what he reads in an agricultural paper blindly. I remember reading in the agricultural columns of one of the leading newspapers in this country years ago that there was no land that would not be benefited by underdraining. The man that wrote that did not know that within one hundred miles of New York, where the paper was published, there were thousands upon thousands of acres of land, naturally underdrained by a gravel subsoil, where an amateur farmer following his advice might lay miles of drains and never a drop of water run through them. It is only a few weeks ago that I read in a leading agricultural paper that meadows should never be pastured in the fall. The reasons given were that the cattle or horses would tread up the turf and eat down the grass so that the roots would be unprotected during the

winter. That man's observations probably lead him to that conclusion, but were he to see my meadows on the first of October in any year, he might think differently. The soil is such that I may follow J. B. Olcott's advice and allow cattle and horses to tread it with benefit rather than injury, and I must mow off a second growth or pasture it off to prevent it smothering the grass roots. In the meantime the solid and liquid excrement dropping on the surface of the soil helps materially in insuring a good crop of grass the next year. This plan might not work on all farms, but with half the stock I now keep I formerly bought hay, while now we are bothered to know what to do with it.

There are still farmers in Connecticut that, notwithstanding all the discussion of the subject, by farmers' conventions, and all that they can see on their live neighbors' farms, will haul out barnyard manure, leave it from one to four weeks to heat and lose its ammonia, while it is spoiling the little spot on which the heap stands, and, when they are ready to plow, spread one row of heaps and hurry to plow it in. If these people would try surface manuring, instead of following the ideas orthodox forty years ago, they might find that their land would not grow less and less productive.

You may think me a crank on the subject of surface manuring, but an experiment made two years ago and a little experience the past season has not weakened my prejudice for this manner of applying fertilizer. We grow potatoes with the use, at the time of planting, of commercial fertilizers only. In 1897, tired of having seed burned, in spite of absolute orders not to let the fertilizer and seed come in contact, I suggested to the boss on my farm that he plant two rows of potatoes across a field, and throw the fertilizer on the spots. Late in the summer the boss and I were passing that field and I inquired what kind of potatoes those two green-topped rows were. "Same as the rest; that's where I put the fertilizer on top," he answered. The balance of the field was badly blighted. When digging time came, those rows yielded much better than the rest. In 1898 we planted all our potatoes in that way, and when, in the hot, wet weather of late summer, my neighbors were complaining of blight, I was rejoicing in the prospect of selling a couple of hundred bushels of potatoes grown at a profit. Having got that idea into my head, I went into the garden with it and, after planting cucumbers, melons,

squashes, and beans, I dusted the hills over with fertilizer. We had an abundance of all these things, some of the water-melons weighing over thirty pounds and being of extra quality. I was particularly impressed with the effect on some lima beans. Looking over the patch after the beans were up, during a dry spell in the spring, I was surprised to note that the ground around the beans was damp, while the sandy soil between the hills was, on the surface, as dry as ashes.

Right here let me break in to say that the farmer that lives where lima beans will grow should grow them. They are delicious eating all the fall, and when frost comes the green ones can be put in a cool place and eaten until well into November, while the dry pods are laid up for winter. After eating baked lima beans for one winter, but few people will grow other beans for that purpose.

You know a lump of potash exposed to the air will absorb water enough to disintegrate it. I have no idea what the fertilizer that I used was, as I trusted our friend Sanderson of New Haven to send what he pleased, but I imagine it contained potash enough so that, exposed to the air, it absorbed moisture enough to keep the bean hills damp. There was seemingly another benefit. I have until last summer been obliged to get up early when I was at home and hunt cut-worms. Either Sanderson's fertilizer or some little chickens that could crawl through the wire netting around the garden relieved me from that work the last season.

I am not about to advise you all to plant your farms and gardens henceforth on my plan, but try it in a small way and then use your own judgment. If you find on the first trial that you get more and better potatoes, and that your garden grows more luxuriantly, try it again.

Possibly if you have labored under the delusion that the Creator did not so make his laws that the excrement from an animal falling on the ground was in its best place, you may in time get rid of that idea.

I want to say a few words about weeds. I know how much has been written and said as to their drawing upon the fertility of the soil, and the necessity for killing and burning to get rid of the seed. It would fill me with deep grief to find that I had an acre of land that would not grow weeds. I do not refer to Canada thistles, wild carrots, and similar noxious weeds, but to the ordinary weeds that grow in tilled land. I

once plowed in a field of some four or five acres of clover against Mr. Gold's advice, and was sorry for it. From my experience and observation I would rather have a nice growth of the common rag weed, sometimes called bitter weed, than a nice growth of clover to plow in.

A facetious uncle of my wife's once called at the house and inquired for me. Finding I was away, he said it mattered but little, as he only wanted to engage a half bushel of mullein seeds, and he thought I should have that amount to spare. There was a field of thin soil near the house that, not wanting to buy fertilizer for in the spring, I had to let lie idle, and there was a splendid growth of mulleins on it. In the fall, wanting to sow the field to rye, as a cheap way of getting rid of the mulleins, I had one man run a plow while another went ahead, pulled the mulleins, and laid them lengthwise in the furrows. They may not have been as valuable as tobacco stems, but they did wonders, and, although millions of ripe seed were plowed in, not a mullein has grown on that field since. I have known other cases where undesirable weeds seemed to have got tired of growing on land, but I assume in this particular case the fact that the land, after the mulleins were plowed in, was too valuable to lie idle, and has consequently been cropped every year, had something to do with the outcome.

If weeds spring up so as to interfere with the growth of crops, I cultivate and kill them. Here I think they are in many cases a God-given blessing, for there are plenty of us that would not cultivate half enough if it were not for the weeds. When weeds are not interfering with a crop I rejoice to see them grow, and if I cannot plow them in I harvest them and put them in the barnyard or pigpens.

Reverting to newspaper advice, I read in a leading agricultural paper a few days since an article on "The Passing of the Ox," written by a citizen of Connecticut. Had he attended any of the fairs in western Connecticut during the fall of 1898, he must have been impressed with the idea that, as he said, the ox was "passing slowly"! He must also have wondered where all the horses were that were to take the place of oxen. Had he tried to buy a pair of good working oxen, he would have found that it was quite an expensive piece of business, even in these latter days. He could buy a pair of work horses, railroaded from the far West, for very much less than

he could go on to a Connecticut farm and buy a good pair of working oxen.

There is occasionally a man that can use a decent pair of road horses on a farm. In nearly forty years as a farmer I have found one such man, and such a man can get more work from a pair of horses than from a pair of oxen. Anyone can use the western farm plug that is brought here and sold at from fifty dollars to seventy-five dollars, but I would rather pay a little more for and would rather use a pair of Devon steers. For continuous work, the horse is the best, but for the intermittent work on the ordinary farm, the ox will be used in Connecticut long after the passing of us all.

In the editorial columns of the same paper I find the question as to whether good roads have increased the value of farm property, and the editor proceeds to argue that such was not the case. The paper is published in New York city, and in a day's drive from his office I could show him that facts are not in accordance with his reasoning. In the first place, there are miles and miles of miserable roads that it costs more to maintain than it would if they were put in good shape. The farmer does not need, and cannot afford, to pay for an asphalt road, but a good road, a common sense road, is as valuable to him and will increase the value of his property in the same proportion that an asphalt pavement increases the value of city property.

I have known just one city man to locate in the country on a wretched road. It showed his lack of common sense, and he followed it up by wasting \$10,000 and moving back to the city.

In conclusion, allow me to say that, contrary to what we so often hear and read, there is a profit to-day in almost any kind of farming in Connecticut, provided that the farmer and the farm are adapted to the business undertaken.

A man with a worn-out, five hundred dollar farm cannot keep a pair of horses for pleasure driving, and support a family in luxury upon the proceeds of the farm. But a Swede will come along, buy that farm, raise a family of children, send them to school, increase the value of the farm, and save money at the same time. He raises a patch of cabbage and another, possibly, of Swede turnips, has a few strawberries, and his wife and children, during the summer vacation of the school, pick wild blackberries in a back lot, or, if he has cleaned up his

fields, on the fields of a less industrious neighbor, and his wife or the eldest boy will take everything to the nearest market and sell it for cash.

I can almost hear some of the ladies in the audience asking, "Would you have us pick wild blackberries and take them to market?" My answer is, no, I would not have you live on such a farm, but, if you are living on a farm, and the good man can not earn enough to pay expenses, I would advise you to pick blackberries, or advise him to sell the farm.

In short, the common sense farmer will act as his best judgment dictates, raising fruit, making milk, butter, or cheese, keeping cattle or horses, as his taste dictates, and, if he finds he cannot make a living in that way he will show the best of common sense by disposing of the farm and getting into some other business. There are ten failures in almost any other business to where there is one in farming, but the farmer that is a failure might make a success in some of them.

The CHAIRMAN. The next lecture for the evening is "The Citizen's Duty to the Public Schools," and I now have the pleasant opportunity to present to you a lady well known throughout this country wherever schools are kept, Mrs. Alice Freeman Palmer, of Cambridge, Mass.

THE CITIZEN'S DUTY TO THE PUBLIC SCHOOLS.

MRS. ALICE FREEMAN PALMER, CAMBRIDGE, MASS.

Mr. President, and Gentlemen: I am sure I am very glad that you have chosen as the subject for a part of your evening's proceedings the one which your chairman has just announced, for it seems to me just now there is no other more important question that we can ask than what are our present relations to the public schools? We are so in the habit of speaking and thinking on that subject here in New England that perhaps some say what has this come up again for? We have done nothing but think, and talk, and plan, and support the public schools for the last many generations. There is nothing new on the subject. Let us see whether there is or not.

It was not long ago when there was before the State Board of Education of your neighboring State the question of schools, and what should be done for the little children in my State in

some of the lonely farming regions, and an able young farmer said: "What is good enough for my father, and what was good enough for me, is good enough for my boy. We do not want any new-fangled notions in the schools." I looked at this eager, able, young farmer of thirty-five as I heard that, and as he more and more urged his opinion, and I thought if only you to-day had something besides what that little school in your neighborhood has given you, perhaps you would be stronger and abler for your work than you are. For awhile it may have been good enough for your father, and it may have been good enough for you; whether it was or not, that has nothing to do with your little boy. That little boy of yours has been born into another world, far different from the world you were born into. The conditions are far different from those of the world into which your father was born, and which he had to face.

The whole question is a new question, ladies and gentlemen, and it seems to me as we go about among the schools it has come to be a new question. What is the best thing we can do to meet the new and changed conditions that confront us? What may we do that we may do our full duty to these dear boys and girls in our public schools? There are many reasons why I think the subject is so important. And the first is that this subject which comes before us to-night involves so many. It is not a question of just a few; of here and there a boy and girl; but it is a question of tremendous importance and consequence to so many. There are almost sixteen millions of boys and girls in our public schools. Almost half a million teachers in our public schools, and a great majority of them young women, to whose trembling, slender, young hands are committed the charge of all these millions of boys and girls coming up so soon to be the masters and mothers of this nation. Then here is the second reason why it is so important; it is not simply because there are so many, or because it involves such an enormous mass of young lives from the Atlantic to the Pacific, but their school life is so brief. While we are talking and planning so fully and so fast, before we realize it, almost, these little boys and girls whose heads were at our knees, as it seems to me, yesterday, are out of school and launched into the trying life of our modern times. Their school life is so brief. It passes so fast, and there is so much crowded into it that what we do we have got to do very fast indeed. That is how it is

here in New England, which gives the most chance to her children of all the sections of this country, the vast majority of our children are out of school, and the serious business of their lives beginning when they are scarcely more than fourteen or fifteen years of age. All the hard struggle of life before them, with their living to make, and support to win for those who are dependent upon them. And all this when they are so young. When they are so little. There is no time to waste. If there has been a loss of time, or a mistaken policy of method of teaching, it cannot be made up, because they are out so soon.

And the third reason that I want to refer to is the vast change which has taken place in our modern conditions, to which I have just alluded; a change that these boys and girls are to meet. We have felt more of it than we ever did before in your life and mine since the civil war, but we have felt more of it than ever before since the 21st of April last. What a change has come to pass among us, and our boys and girls are the ones who are to meet it. A neighbor of mine, upon whom I occasionally call, said to me one day when we were seated in her sewing room: "Oh, it takes so much more brains to be good now. It takes so much more brains to be good now than it did when I was a girl. If I was a fairly amiable daughter in the family, if I went to church three times on Sunday, which was the fashion in those days, and did for those around me the best I was able, I was sure I did my duty." And I thought if we could only teach our children to do their duty in the difficult years that are to come. Teach them how to be good, and do their duty. That is the work which is laid upon us now to do in our public schools, and the work is of tremendous importance. Days are ahead of them with duties to perform which have not been imposed upon you or me. How shall we prepare them for it? What shall we do as citizens of this great republic to prepare our children for the mighty work of the coming years? These little children of ours now in the public schools and who are so soon to stand in our places. What can we do for them to enable them to carry on the work better, to be larger and broader-minded, and wiser than those who have carried it thus far?

The question comes to be more serious because of the vast changes that have already taken place. If we could have this same practical common sense in the guidance and control of

our public schools it would help the matter greatly. If we could get our school boards to recognize the responsibility of the hour. If we could get them to consider and speak the truth upon this great subject. Society has almost been transformed in this one last generation. There is now one-third of all the population living in the cities of more than 8,000 inhabitants, when before the civil war there was not ten per cent. living in those cities. What a change this has made in the up-bringing of the children.

I often think of a scene which I saw one day with my husband while we were climbing up one of the mountains of Austria, pushing our bicycles up the slope. When I remember this incident I always think of our New England homes and what they stand for. We were pushing our way up the mountain when we heard the voices of young men singing up above us, and by and by we were able to see them through the zigzag road as they kept their way up. There was quite a company of young men in their picturesque native costumes, with feathers in their caps and flowers in their button-holes. They looked back and saw us, and then they all sat down and waited until we came up to them. They watched us closely with our wheels as we came up. We seemed to be quite a curiosity to them, and I was in favor of sitting upon the mountain-side until they passed up, but my husband knew just what would happen, and he told me: "You ought to be very thankful you are giving them so much pleasure." I was in my climbing costume. So as cheerfully as I could I passed up the hill and there they were, still waiting for us.

There was one among them who spoke German, while all the rest talked their native mountain dialect. The young man who spoke German took off his cap, and bowed to my husband, and he said: "May I walk with you?" Courteously as we could we gave the necessary answer, yes. We passed along, and the young man said: "You must be Americans." Yes, we answered, that is why we are here, because we are Americans. "Is that so?" said the young man. "We know a great deal about Chicago, and the World's Fair that was there, and the Americans." "Did you ever hear of Chicago?" Yes, we had heard of the place. "Oh," he said, "but we know all about it. We have heard that in America the ladies are very queer, and that they ride these machines. We do

not believe it. Is that done yet?" I still was silent. And then this young man added, to my husband, "Won't you please make her show us if she can?" Well, my husband said, she does not do it up the sides of a mountain, but in this splendid air she rides down. And then he said: "It is only two hours' walk to the top of the hill, and we will go up, and then will you make her ride down and show us?"

And thus our acquaintance began — on a lonely mountain path in the heart of Austria, and as we walked among those great mountains for two hours we had long talks, and I said to my husband: "Since I must show them if I can ride, they shall tell me some things I want to know," and I was about to proceed to ask some questions, when the young man said: "We are all going to America, everyone of us. We are going to live there. We are going just as soon as we can get money enough." And then he proceeded to tell me how much each one had saved. "Just as soon as we have money enough we are going to a place they call New England. Did you ever hear of a place they call New England?" "Yes," we said, "we had heard of it." "We are all going to live there, every one of us."

That is the way it is all over Europe. The eyes of the young men are turned towards us as to a land of promise. I had a snow-white haired man take my hands, both of them, in his, and with tears in his eyes, when he found I was from America, he said: "Tell me about my boy. You come from America. He has been there so long, and I have not heard from him for a long time. He was sick when I heard. Tell me about my boy." So it is. I remember how a sweet but toil-worn woman threw her arms around my shoulders when she found I came from America, and she said: "Tell me news from my girl. I must hear from her. I am sure you know her." Where is she? She said she lived in a place they called Texas, and she knew I must bring news of her.

So after experiences like that I said to those boys: "Don't go to America. Stay here with your fathers and mothers. And the oldest one replied: "We can't stay here; we are so lonely. They are all gone to America." We urged it upon them. "Stay here with your parents. Make life sweet for them." "Oh, no; we cannot. We are all going to America." Strange talk, wasn't it, to meet with in the heart of Austria? And they were all going to a place they called New

England. "We know in New England you are all rich. We have heard all about you. You are all rich, and you are all good, and you are all happy, and we want to live there with you." Said one of them, — I thought he was a little boy himself, — he said he was nineteen: "I have a little boy myself, and I want to take him there. I have heard you have the best schools in the world." I remember as I rode down the path I heard their cheers. I showed them I could.

Awhile ago I returned home one night and I found some letters, and one of them was from a child in Virginia. She said: "Won't you let me come and work for you, because my boy is twelve years old, and I want him to be a preacher. My father could not give me the education I wanted. He was a slave, and bought himself off in work, and just after paying for himself, and he had begun to pay for my mother, he died, and I could not have any more schooling. My boy is going to be a preacher, and I have heard in the South as how the best schools in the world were up North. Won't you let me come and work for you, so my boy can go to school. I have heard your husband is a professor. Won't you let me come and work for you, so I can put Amos through Harvard College?" Well, I left her in Cambridge putting Amos through Harvard. With these experiences, I think, dear friends, of the blessed inheritance of New England traditions, and of what the Austrian boys in the mountain passes said of the place they called New England, and of what the child of the slave said from her home in Virginia, and of what we are possessed of in the life of the spirit. Oh, these precious influences of New England life, shall they be strong and clear and brave in the next fifty years as they have been in the past? In the fifty years of the next century, with its great, grave, new problems, will we meet the issues and triumph because we ought? This is a very great subject, but it is not a question which will be answered as you and I want it to be answered unless we discuss it as a new question, and unless we turn aside from the old ways which, as I have said, some think are good enough.

Now, with practical men and women on the farm and in the cities alike, the question is, what have we got to do to equip our boys and girls in the next generation for the high responsibilities which will rest upon them? Under such circumstances, what can we do besides holding fast according to our

splendid old tradition to all that is good, — how can we hold that fast and yet add anew to it? How shall we train the boys and girls who are going out to rule the next century, and the larger world that will be put into their hands? What is our duty? And what do they need?

In the first place, we must have men who have the active management and organization of our schools, and who choose the teachers for them in our towns and cities and villages, — we must have men who catch the gravity of the situation, and who recognize that this is a question of the most vital national importance. We have not yet that kind of men on our school boards for all our schools or it would have solved the question. New England must maintain her leadership. We have grown so fast, new political and social problems arising, and if New England would maintain her leadership she must have schools which will train the children to solve these great questions as they arise and demand recognition. Many of the institutions in the great centers of the interior part of the country are asking if we are going to maintain our old leadership. Unless we do, with the new strength of the population west of us, what shall we have to give for leadership? Now what shall we do to maintain it?

The first thing that one asks is that our schools shall be free. And while that seems surprising, the fact is, dear friends, our schools are not free as they used to be, except merely that our children do not pay any money. They are free in that sense, but, except in that sense, they are not so free as their name implies. Let me illustrate to you what I mean. In one village that I know of they are so neighborly that one old gentleman still wants to stay in the school after twenty years of service, and the school committeeman was so neighborly and so anxious not to hurt the old gentleman's feelings that he was retained in the position. They never asked exactly what is the best thing for us to do? He never stopped to ask, is this the best thing that can be done for these boys and girls, that they may have the best advantages and fitted to go out into the great world to grapple with the problems of the people? In so many of our communities this idea of neighborliness, of doing what this neighbor wants, or what that one wants, and giving him the position he wants, overrules the sense of what is best and makes our schools far from perfect. They are not free when this is going on. They are

simply made the slaves of over-generosity and sensitiveness and fear of offending a neighbor. I know this is so in my State. I know it must be so in others, and where our schools are handled in such a manner they are not free, for they are made subservient to the neighborliness and the sensitiveness and the fear of offending those who have them in charge.

I know of one village where there is a good-hearted minister. He likes to manage things. The other day there was a very bad boy taken out of school. He was a mischievous boy, but his mother went to the minister, and they sent in a petition and the bad boy was taken back into the school and he still rules that school. That is not a free public school. Where such methods rule, our schools are not free. They cannot be free. It is not a question of the best possible teaching, and who needs this instruction the most and in the best way. The school is simply a charity organization to take care of some person who needs a position. Now we have got to that point where we have got to free our schools from parties; where we have got to free our schools from being the victims of this kind of good-nature. Is it not so? I am sure it is so. In Massachusetts we are being concerned more and more with this question. It is not a question of neighborliness, it should not be a question of political expediency. It should be a question of what is best for these dear boys and girls of ours, how to give them the best advantages possible, the best training possible; that should be the only question. What is the best thing now that the most public spirited and sweet hearted men and women of our country can do for the boys and girls? What is the best we can give them? That is the only question. What is the best we can give them to fit them for the future? And is it simply a matter of instruction? Is this enough, dear friends, and when we have done that have we done our duty? One thing is sure. Certainly it is not our limit. It is not the limit to which our endeavors should go.

When we have freed our schools there are other elements of this subject to which we should also give attention. And there is one thing in particular we ought to do. We ought to give them a foundation of health. I am sorry to say that a vast number of our school buildings are erected without reference to that important question. Those who have had charge of them have not stopped to ask the question, is this the best location, or the most healthful one? We have been so busy

with other things that we have not paid proper attention to this important factor in this problem, but we are beginning now. In Boston it happened two years ago, when we found that more school children of Boston, with its enormous wealth and population, more school children were dying of disease than in Vienna, or London, or Paris, or Berlin. I mean in proportion to the numbers. And while we were asking ourselves why this should be we found how imperfect was the drainage, how bad was the ventilation, and how unsuitable were the desks, and those things all went to show that we were not doing all that modern science and modern opportunity made it possible for us to do for our children.

This is one of the things that is pressing to the front, so that we may not only give our children the necessary instruction, but that they may have deep lungs, calm nerves, and clear brains, as well as generous hearts. We cannot do that unless we take advantage of all that modern sanitation and the laws of health show us ought to be done. A child has a right to it, I am sure, as a child of the State. It is not a matter of cost as much as it is a matter of time and the result of care. We have not made our schoolrooms really bright. We have not made them wholesome and sweet and fresh.

Shall we do something else for our fortunate New England children, the children of our villages and farms? Shall we not give them another dip in science? It seems to me, dear friends, and I speak with a great deal of feeling in any convention like this, it seems to me that one of the things that we cannot ask ourselves to do for our children too soon, that is to give them some instruction in nature's studies; that our children shall be given not merely the sense that nature is a good thing to know, but that our children shall be given such a training that they shall feel and love their home among these beautiful New England hills; love their homes at their fathers' houses upon the farms instead of regarding them as simply a transient place of residence, as is too often the case.

I do not know how it is with you, but my school days were in a village in New York. I went to school over the lovely country ways to bend my young head for hours over lines of books, the lengths of rivers of South America and Asia, and the heights of the mountains of Africa, and the populations of the cities in Europe, and all these things that are ordinarily taught, but no teacher I ever had ever thought to ask me the

names of the trees that bordered the road along which I walked to school. I cannot remember of ever having a teacher intimate to me that it would be well for me to know personally the names of the flowers at my feet. Do you not say, you farmers, that your lives would have been sweeter and more joyous if some such instruction as this had been given you when you were boys in the hillside schools? Would it not have been a source of comfort and of joy and of uplifting? It would have been if the correct thing had been done. It will be now if we rectify the errors of the past and give our children this instruction, give the boys and girls of our beautiful rural New England district this instruction which will be such an uplifting and joyous element in their lives. It is not a difficult thing to do. Happy to-day are those young people who are doing it! You see them in the midst of their children. There are some in the midst of their children who are teaching them about the planets and the stars over their heads, who are giving their children lessons in these matters beyond their years, and in terms that they cannot understand. But how happy are they in these schoolhouses where instruction somewhat upon the line I have suggested is given. I have in mind now a little country schoolhouse. I think there are about eighteen children when they are all there. It is a little ungraded school. The young teacher has had her eyes opened. She is so eager. I was pleased to hear one of the boys, who had already been asking that we would find him a place in the city, to hear this boy say that it was pleasanter to stay on the farm. There were so many things interesting that grew on the farm.

We made an offer in that school of a prize to those boys and girls who, before the 15th of May, would bring to the teacher the most of the little branches with tent caterpillars' nests on. I had the pleasure of knowing the extraordinary number that the little boys and girls brought from the orchards and fields. I do not know whether it is a very safe thing to suggest to any school, but I am sure there were three or four boys that put in a very busy month in hunting over the farms for these little caterpillars. I think we all thought they would bring in one hundred or more. We offered them ten cents a hundred branches with the tent caterpillars on them. You may be surprised to know that we had to pay \$41 before it was over. It was very bad for the caterpillars and very

good for those children. I tell you of it, not because of our disaster, but because of the effect that those prizes had on those children.

It has been only two years, but those little boys have practically learned to study the branches of trees; to study the trees and to understand them. And from that they have come to the insects that destroy their fathers' vegetables. They are thoroughly aroused and are forming an Agassiz society. They are in love with nature. They want to be scientists. We did more than pay for a large number of caterpillars. Their eyes were opened, their ears are attuned to the music of the woods, and life on the farm has grown more interesting to those boys and girls of ten or twelve than they ever thought it could be before. Let us give them all this lesson in our schools. Let us give it to all our boys and girls in the schools of our rural districts that their eyes may be opened to the enjoyment and the pleasure which comes from the study and the knowledge of the things of nature. It is not a question of cost so much as it is a determination to give them this instruction which will broaden and deepen their lives.

I want to ask you if we should not give them something else? I want to ask if we should not teach them not only to love the farm and to love nature, but to love all that is lovely? Should we not also give them a practical training, so that they may do as well as to see and to think? Most of our boys and girls on the farm are far more fortunate than our city boys and girls in that they have the opportunity of learning how to do. Fortunate is the child of to-day who has this practical training.

The other day I was watching some girls making bread in a cooking school. I thought I had never seen such triumph as I saw in the eyes of those who made the best bread. My friends, you gentlemen that have been brought up in our country schools have had the opportunity of being trained how to do, but many of the children of our city streets have not this opportunity. I thought I never saw such pleasure as was depicted in the eyes of those girls who had made the best loaf. Many of our boys and girls are dreaming that they can be triumphant and heroic if they could paint a picture or write a poem, or if they could play on the violin so exquisitely, but none of them, even if their childish dreams were realized, could have attained greater happiness than those who had

learned for the first time to make the most perfect loaf of bread, or the most exquisite glass of jelly, or she who learns how to trim her hat with daintiness, or makes her new dress charmingly, and in good taste. She also is a poet and an artist. We need to teach our boys and girls this. They are so hungry for it. We ought to teach them the artistics. I saw in the Berkshire Hills, in a little schoolhouse, a group of boys and girls bending over a lot of pictures that had been loaned by the Russell Society for education, and which had been sent up for them from Boston. They had no library in that town, and they had few books, and these short winter days and long winter evenings must have lacked entertainment; but these ladies had made some pictures, and had gathered them together and sent them up to this town in the rural districts of New England; perhaps a hundred or more pictures. And they were so interested in them.

As an illustration of this love of art, let me tell you a little incident. I never forgot it. There was a country school teacher that I met up on the hill of Mars; when I saw her she told me she had accomplished that day two things. She had seen the King, and she had stood upon Mars Hill. She said to me: "I have taught school ever since I was eighteen. I am sixty-three. I have done my duty and my boys are all young men, and my girls have grown to young womanhood and taken up the duties of their lives, but I always said that I never would go into my grave until I had saved enough to see two things. To-day I have done both." There is this love of the classic and artistic in the children that attend the schools of our New England hills and villages. Let us cultivate it. Let us give them the joy that comes from its cultivation. Dear friends, there are many people in the world that would go far and spend much to stand beside the grave of a poet. Let us recognize it. Let us develop this latent talent, this latent taste which can be brought out in our children. Let us give them this knowledge. If nothing more, put the cheap color on the wall rather than have no color at all. It costs so little. Let us give them now and then pictures. Now and then give them a book. Let us do all we can.

I remember a teacher who did the most for me that had just one row of books, and when little children in this country schoolhouse were very good indeed, very good the whole week, they were allowed to have one of those books to take home to

read. It was not a dainty book of the modern sort. It was something so different that we didn't half understand it. But I remember how proud we were and how glad to get a chance to read them. I remember how much company Bunyan's "Pilgrim's Progress" was to me. I remember the pages so well, and those words, although I didn't quite know what they meant, went singing down through my head ever since. It aroused a love of books. How much we shall gain if we can give our children a love of books and if we can give them a love of nature. If we can give them open eyes towards beauty; if we can give them open ears to the music of the fields and woods. What are we supporting the schools for? I think it is for two things. To give our boys and girls who are to take our places not only the training to wrestle with the practical problems of the future, to fit them for the hard service which is to come, but we want them to be capable of enjoyment, and it is a greatly added element of their capacity for joy if they love noble books, and if they love the lovely world into which you have brought their young lives. If they love beauty; if they love their fellow men, they will be happy and they will be good, and they will have a sense of joy that nothing can take away. Shall we be satisfied with giving our splendid boys and girls of New England anything less than this? As I go about among the schools I am sure they deserve the best. They deserve the best that the advance of modern progress has suggested. They have been pretty lonely. They don't like the old-fashioned things that some of us knew. New conditions have arisen. They must be trained to fit these conditions. They are entitled to the best. Let us see that they have it.

The other day there was a great German in this country, and in a very surprised tone he said to my husband: "I wonder why it is that in America nobody seems to like the law. Nobody seems to wish to obey the law; everybody seems to want to do something that is not lawful." My husband said: "What do you mean?" and so far as he could see he had only been as far west as the Mississippi River. But the gentleman said to him: "There is only one explanation which I can make of your apparent lack of respect for the law, and that is that you make the laws yourselves and therefore you do not much respect them." He went away. He took the boat for

home because we made our own laws. He will probably write a book about it, and then we may know what it is to which he objects so strongly. Our boys and girls have ambition; they have motion; they have charm. Let us give them the practical training that will make them able to do, able to see, and able to think. Three difficult things which are still not often found in the New England schools.

When we want anything that is to be well done, how difficult it is to get a person who can do it. How difficult it is to find a person who can see, and think, and do perfectly and correctly the thing that is needed. In our schools can these untrained young teachers, who so often have given into their hands the training of our boys and girls who are coming up to take our places in the future, can they be expected to produce the highest results unless their training has been the best that we can give them. And we should remember, too, that among the boys and girls of the present are the teachers of the future, and how important it is that they should have the best that modern methods and modern ideas can give them in the way of instruction. These young teachers can do far more year by year if we all assist in the work. If we all of us agree that the moment is coming when we must not only cull the best that the past has taught us, but we must use the best that our experience and our judgment teaches to fit these boys and girls for the future.

Of course the changed conditions of the times, and the lessons which are drawn from the stirring events around us, of course they will learn anew in all the little schools. They will learn something of Cuba, and of Porto Rico, and of the Philippines. There are many little things which they will learn, but will they learn to take care of the islands of the sea, far away, which they never heard of six months ago? Many of these boys will be pressing forward for the offices in these far off islands of the sea. Shall we not teach our boys and girls not only the geography of our country and its new possessions, but let us teach them also, as well as geography and history, to be generous, high-souled men and women. Shall we not give them a high ideal of what the great nations in history have accomplished? Shall we not also teach our boys some new United States history, and give them large notions of what a brave free nation must be; and must do, if we shall have the right to say when we look across the pathless ocean

to the Ruler of the Universe, it was our duty. Let us train our boys so that when the call comes for generous, brave, and high-souled citizens to fill the places which will be created among our new possessions they shall step forward and say: "Here am I, send me." If we are brave enough to do that; if our preparation attains that, then we shall indeed take a great step forward in the training of the little Americans who to-morrow are to be the rulers of America, make our homes, govern our churches and our caucuses and labor in our state houses and in the halls of legislation, as well as upon our farms. For my part I believe New England will in the future, as in the past, hold her own. I do not believe that our day is past and that all the force and power has gone into the Middle West. I do not believe that. I believe still that the farms of Massachusetts and Connecticut and the little New England States will not only raise good potatoes and lima beans, but splendid boys and girls, as in the old days. I believe there will still be men and women here who will think, and dare to say what they think, and we shall send out beyond to the far away, not only to the Pacific coast, but even to the islands of the Pacific, not only men who can fire a gun straight, but men who, having ruled themselves, can rule the world.

The CHAIRMAN. If the Chair may be allowed a moment or two, I would like to say that we all fully concur in this beautiful lecture we have listened to this evening. I was forcibly struck with Mrs. Palmer's allusion to nature, because in my city for a number of years classes from the public schools and the normal schools have visited my place on purpose to acquire a knowledge of trees and shrubs. I have in my grounds perhaps one hundred varieties of shrubs and trees which give quite an opportunity for teachers and scholars to inform themselves in that line. I have also a great many kinds of flowering plants. I think as time goes on that we have got to make a great effort to beautify this country and the country farms. That is a branch of farming which has been sadly neglected and which should be promoted without any further delay. It is within the power and the scope of every thorough farmer to beautify his place by tree-planting

and by decorating it with shrubs. We have been favored in New England with a great many good school teachers.

Mrs. Palmer has not said anything of Wellesley, of which she was formerly president. I mean that famous female college. It has adjoining it the most beautiful grounds that we have in the commonwealth, and the students have full access to them. Mr. Hunnewell's is one of the most beautiful places on this continent, and when people go there it is an object lesson in tree-planting. It has been going on since 1852. I avail myself of the privilege of going there once a year and always find something new. While I am a plain farmer, I am fond of trees and shrubs. I know very little of botany, but my wife is quite a botanist, and I console myself with the expression of a certain writer who said that he never knew a good botanist make a good cultivator.

I have in my mind a little incident. John Quincy Adams taught school in Worcester about 1775 for several years. He was once invited to dine with a prominent family, one of the old families of our city; and those were in the days of King George, and they proposed a toast to the health of the King, which they drank. Adams felt a little disturbed, and so he proposed the health of the Devil. This pained the host somewhat, and his good wife, to get out of the difficulty, said: "While the gentleman is drinking the health of our friend, perhaps we may do our duty by drinking the health of his."

A MEMBER. Mr. President, I know in the Grange to which I have the honor to belong the question has been discussed somewhat as to the duty of the citizens to the public schools. I think we ought to do something to improve the surroundings of many of our country schools. The suggestion has been made that in our farming regions, although the land is usually cheap, the schoolhouse is situated in some out of the way corner where no sunshine can reach it, and there has been but very little playground for the children to run over. Now I think it ought to be so that no school buildings in a farming

region should be built without an acre of land for a playground, and for the purpose of setting out such shrubs and plants and trees as might be grown, and then the teacher might have, on the school property, a chance to teach the children and the people how to care for those shrubs and plants. Now I can see that where the land is valuable this would not be so easy. But in our country towns we have got any quantity of land which would not only make a pleasant place for our children to pass their noon recesses, but it could be set out with trees and shrubs and decorated with foliage plants so as to make it attractive and pleasant, and it would be in line with the instruction in nature topics, as has been suggested here. As I drive through the country I see very few of our school-houses thus favored. The cost would not be great, and I believe in our country towns we might take that into consideration and be a little more generous toward our children who attend the country schools.

Mr. SEELEY. Mr. Chairman, I think that Mrs. Palmer touched the keynote in this matter when she alluded to this point; and that is, give your children something to do. Teach them to do something. I remember a very noted minister who formerly preached in Connecticut, and also, I believe, in Northampton, Mass. In one of his sermons which he preached when I was a boy he showed what a harmful thing it was for a young man or a young woman to grow up feeling that they had no responsibility in life, or that they didn't care to assume any responsibility in life, or to grow up feeling that all they were here in the world for was to have a good time. When you impress upon a boy or girl the idea that there is a little duty for them; that there is some little responsibility for them to assume, you have done a better thing for that boy or girl than most anything else which can be done. Let them feel that the whole world is depending upon their doing that little deed, or that little piece of work, and that no one else can do it, or do it as well. I think there is no other way in

which we can train our children to a proper idea of the responsibility of life than by starting when they are young and impressing upon them that they have their little duties to perform, little tasks to do which will be expected of them.

Mr. E. Hoyt. I think, Mr. Chairman, that this work of teaching the school children nature studies is being taught some in the schools. A teacher in Brooklyn this fall sent up to me and asked if I would send her down a variety of leaves of trees and shrubs. She said she was teaching her children botany, and if she had some illustrations of the different leaves she thought she could do it much more intelligently. I showed the letter to the foreman and told him to select all the leaves he could and send them down to her. He did so, and he told me that he got about seventy-five different specimens. So we can see from this that in the cities where they do not have the opportunities that we have in the country towns they are studying nature. I should be very happy to supply any school teacher who wishes a collection of leaves from forest trees and shrubs.

Mr. Gold makes the announcement for the following day, and the convention adjourns until Thursday morning, December 15th, at 10.30.

MORNING SESSION.

Thursday, December 15, 1898.

Convention called to order at 10 A. M., Mr. Seeley in the chair.

The CHAIRMAN. You will notice on your programmes that Mr. Powell was to lecture at 10 o'clock upon the subject of "Fruit Culture, Orchards, and Small Fruits." But, at request of Mr. Powell, an exchange is made, and we will have Mr. Hale this morning and Mr. Powell this afternoon. I do not know of anything which I can say in introducing Mr. Hale to you, for he is pretty well introduced already. He is a pretty "hale" man, and I am very glad to call your at-

tention to the fact that you have a "Hale" man to speak to you this morning.

THE PAST, PRESENT, AND FUTURE OF CONNECTICUT FRUIT CULTURE.

MR. J. H. HALE, South Glastonbury.

Yes, a hale young man, instead of a hale old man. Now, Mr. President and brethren and sisters, the Secretary, in his invitation to me to talk to you, has left me somewhat in the fix that the old Irish lady in court left the lawyer. He had been badgering her for a good while and asking her a good many questions, and been trying to hold her down. "Now," he says, "I don't want so much talk. I want you to locate those stairs. I want you to tell me distinctly how those stairs ran. I don't want any other answer, but I want you to tell me distinctly how those stairs were located." "Well," she says, "when I am down stairs they run up, and when I am up stairs they run down."

Now, when I come to talk to you about the present, past, and future of fruit culture, he is asking me to stand in the middle and look both ways. I have got to be up stairs as well as down stairs, and look both ways. The subject of fruit culture in Connecticut and New England is as old as New England itself. The very earliest settlers of New England were cultivators of fruit. I looked the subject up some years ago. I found that many points of interest in our early fruit culture were published by the Massachusetts Horticultural Society. And I am going to read a little from the memorandum of the record of the Massachusetts Company of March 16, 1629, which says:

"To provide to send for New England Vyne Planters, Stones of all sorts of fruites, as peaches, pears, plums, filberts, cherries, pear, aple, quince kernells, pomegranats; also wheat, rye, barley, oates, woad, saffron, liquorice seed and madder rootes, potatoes, hop rootes, current plants."

That was in 1629. Only a little later, in 1641, our friend, George Fenwick of Saybrook, Connecticut, wrote a letter to Governor Winthrop of Massachusetts, as follows:

"I haue reseaued the trees yow sent me, for which I hartily thanke yow. If I had anything here that could

pleasure yow, yow should frely command it. I am prettie well storred with cherrie & peach trees, & did hope I had had a good nurserie of aples, of the aples yow sent me last yeare, but the wormes haue in a manner destroyed them all as they came up. I pray informe me if yow know any way to preuent like mischiefe for the future."

That shows that our friends in the very earliest settlement of Connecticut, in the very first work that was done in Connecticut in the way of fruit growing, were troubled with some of the troubles we have at the present time. While they probably had a little opportunity to exchange trees, and there may have been a little sale of trees among them, most of the plants for early fruit culture and propagation in the colonies were undoubtedly from exchanges or by buds and scions one with another, but we can see from these quotations that some trees were imported. You will notice in all our old time Connecticut farming, where the trees have been grown right in the ground where they grew, there was a difference in the vigor of the scion and the stock. I have apples where the stock is very much enlarged, very much larger than the scion; and in other instances the stock or the scion is larger than the graft, showing plainly that the local planting of seeds and home grafting had a prominent influence upon fruit production and fruit propagation, and that the production was entirely for home supply. It was a matter of food product in the very early days. I am compelled to think from the records that the early settlers away back in early colonial days had really more interest in fruit culture than our more immediate ancestors of one hundred years ago.

The important part that Connecticut has taken in the development of fruit interests in this country was impressed upon me by looking up a list of valuable fruits that are known the country over that have a Connecticut origin. I made a list of them that interested me, and it probably will you. Not all of the fruits that originated in Connecticut are given, but I give those of Connecticut origin which have been found valuable the country over. This is the list which I have prepared: Coe's Transparent Cherry, Hartford Prolific Grape, Howell Pear, Onondaga Pear, Clark Raspberry, Crescent Strawberry, Worthy Strawberry, Cromwell Raspberry, Jewell Strawberry, Baker Apple, Cogswell Apple, Fall Jenneting,

Golden Sweet, Hartford Sweet, Hurlburt, McClellan, Pumpkin or Pound Sweet, Twenty-Ounce, and Westfield Seekno-farther. All of these are of proved value.

Now, the production of fruit for market to any considerable degree is almost entirely a development of the last fifty years. It is not wholly so, but it is almost entirely a development of the last fifty years. The greater part of it within the last twenty-five years, and I might say even less, but until the last twenty-five years fruit production for market has only been a side issue to that of general farming, except in a few rare instances in different sections of the State. Why, I can remember, very early, indeed, when it was a common practice to market all the apples that were marketed by putting them up in bags. I have seen as fine apples as ever grew put in bags and hauled to market in a wagon without springs and dumped out as we would dump out potatoes. You have all seen that. I recollect a little lesson I learned once. I don't know whether it was a lesson or what it was, but the incident impressed itself upon my memory. I was going to market in the early days myself with a load of apples in bags. They were in these narrow grain sacks, not the broad-mouthed sacks that we have at the present time, but they were narrow cotton bags such as grass seed comes in at present. They sat pretty well back in the wagon, and I remember that I was quite a small boy. To sell I had to stand up in the wagon, and at this particular time there were some street Arabs near by, and one of them rushed up behind and got hold of one of the bags and tipped it a little, and all the apples in that bag strung out on Front street here in Hartford. I was so small that I couldn't get out and lick the fellow that did it, and the best thing that I could do was to offer half a bushel to another one of them to catch that fellow and thrash him for me. I have got an idea that in recent days that method of carrying apples to market still exists. There are men who don't know any better than to carry apples to market tied up in bags and loaded in a wagon without springs.

My earliest recollection of the strawberry market and of the growth and propagation of strawberries, now almost forty years ago, was that only three men in Hartford County produced any strawberries at all, and the whole three of them did not have an acre between them. I recollect seeing those berries which were picked carefully in the morning. They

were put up in those little round boxes, such as you ladies use for spices, and such as you see blueberries going to the Boston market in at the present time. Not slab boxes. I remember seeing those strawberries picked and packed in an old trunk, and this trunk brought in here to Hartford, and then the fruit was disposed of either directly to families or to the one only dealer who handled fruit in the city thirty-five or forty years ago. Go around Hartford to-day and see the fruit stands. You will find them by the score. Then there was only one man in the city who sold any fruit whatever. At the same time all the peaches were marketed in the same crude way. That was the start of our peach market in Hartford. I remember one dealer who bought dollar peaches in New York as they came in, in various styles of baskets, and re-shipped them in barrels. They had regular barrels made for peach shipments. Some of you remember the blue barrels, and some of you remember how they were divided in the middle of the barrel. The peaches were dumped into the barrel, and then there was a wooden partition put in, and then it was filled up to the top, and they would shake it down and put on the cover, and then those peaches were shipped to Providence by boat, and in fact they were shipped all over New England that way. That was the beginning of the peach trade in those years.

Nothing could be said about the past of Connecticut fruit culture without alluding to a few that we might say were very old-timers. The work and the development of the fruit culture business by such men as friend Augur, who at one time was pomologist of this Board, did much to start and stimulate the modern fruit business of the present time. Then there was our old and good friend, Richard Van Deusen, who was indeed a lover of fruit. He was a believer in fruit. And then there was C. H. Lathrop of Vernon, a long-time member of this Board, and others that might be named. Judge Coe of Meriden, a man of sterling worth. They were men who cultivated fruit because they loved it, and they believed in it. They were men who saw away ahead of their times, saw the possibility of New England soil, and the possibilities of Connecticut soil for the production of fine fruit, and they believed that in the future the people would appreciate it more than in the past.

Now I want to say a word right here about nursery agents

and their connection with the development of fruit culture. Aside from the local planting and grafting and home work by exchanges, one with another, within the last one hundred years, or probably mostly within the last fifty or seventy-five years, the growth of fruit culture has been tremendously stimulated in the State of Connecticut by the wandering nursery agent, that missionary of horticulture who has been everlastingly condemned by the majority of people, called an enemy of mankind, a swindling tree agent, and all sorts of epithets all over the country; and yet all over the country you can find fine orchards that are the result of the efforts of these men. You can find fine orchards that any man might be proud of that never would have existed but for the trees which these men sold. To be sure, he has brought you old-time apples and sold you old-time grapevines under new and high-sounding names, and he has shown you pictures of fruits that couldn't be produced this side of the Garden of Eden. He has tempted you with all sorts of pictures, and he has made you pay for Bartlett pears under the name of the great Hungarian pear, or some other equally high-sounding title. He has made you pay a dollar apiece for nursery Baldwin apples. He has made you pay seventy-five cents or a dollar apiece for old-time varieties of peaches and other fruits, that if they had come directly to you, you wouldn't have taken as a gift, and he has shown you all these pretty pictures of impossible specimens of fruit, and has tempted you in all these ways, and he has brought down upon his devoted head the title of a swindler and a cheat; and yet, let me tell you, in spite of it all, he has benefited you immeasurably. You cannot begin to count the value which the swindling tree agent has done to horticulture. There are thousands of fine growing trees all over the State that are a pleasure and a profit to their owners that would not have been there had it not been for the wandering tree agent. So you see you can sometimes do evil that good may come of it.

The old-time nurseries were handled and controlled by men who had a love of trees and for the planting of vines. They were men who in a small way propagated and cultivated every variety of trees and plants that were likely to be called for by their neighbors or by their ever-broadening trade. The old-time nursery produced almost everything in the horticultural line that could be sold in the neighborhood, and these small nurseries were found scattered all over Connecticut

and the neighboring states. The tendency of modern times, however, has driven them all out of the business, and the nurseries have been driven into specialties. They are now devoted to one kind and are paying strict attention to the production of certain kinds and varieties of trees and plants along special lines.

A few years ago, almost every nurseryman in the country produced some grapevines, but now out of the more than four thousand nurseries in America, practically all the grapevines are grown by four or five firms, which grow them by the hundred acres. What is true in regard to grapes is also but not quite as true in regard to apples and pears. It is true to a large extent. Those are some of the conditions that appertained in the old time to horticulture in Connecticut.

The newer conditions are better, a great deal better, because nearly every farm now has a goodly variety of fruit, and many a farm produces it upon an extensive scale. Nearly every farm in the country has a fairly good supply of standard fruits of different varieties throughout the season, so that the markets of to-day are a wonderful sight to behold in comparison with the markets of the olden times. With the growth of cities and towns, and with the growth of manufacturing industries, a great number of our population not engaged in agriculture or not engaged in the production or propagation of fruit in any way have created a market for fruit which is something marvelous in its development in recent years. There is a general buying of fruit now by all people living in cities and towns. I doubt if there is a family anywhere in any city or town or village in Connecticut, with any earning power whatever, or with the most moderate amount of money to spend, but what throughout the year are buyers of fruit to a greater or less degree. I would question whether there is a single family in the cities that does not some time during the year buy fruit of some kind, and there are many others who buy it, or have it in their houses, or on their tables, every day in the year. This has been brought about in various ways, but in none so much, I think, as by the growth of better fruit and the knowledge that beautiful fruit commands high prices as well as commands the appreciation of those who buy it.

It is marvelous to note what the effect of education, cultivation, and refinement is in relation to fruit consumption. The city of Boston, where the Massachusetts Horticultural

Society has held almost all its annual meetings, and where for years it has held monthly and weekly meetings, and whose exhibits have educated the people of that city and surrounding country to the beauty of fine fruit and a knowledge of the different varieties, has become the best fruit market on the face of the globe. Hartford has been fortunate. The fruit growers surrounding Hartford are fortunate in the fact that for a great many years there have been in the city a number of dealers in fine fruit who were also lovers of good fruit. They have appreciated the value of fine fruit and have had the taste, and the desire, and the ability to display it before the public in the markets. Hartford has had in the past, and within a few recent years, a better display of fruit on its stands, and a more tasteful display of the same quality, than any other city in the Union. This accounts for the fact that the result is what it is. Hartford, with a less population, annually consumes three times as much choice fruit, or high-priced fruit, than does our neighboring city of New Haven, with a greater population. I haven't any doubt but what the people in New Haven have as good teeth, and as good digestion and the same ability to buy; in fact, they have everything except the taste for good fruit, or else there is a lack of it among their dealers, for there has never been to any extent a continual fine display of fine fruit there, and it has made a difference of more than 50 per cent. in the consuming power of the two cities, and, I presume, of at least 10 to 20 per cent. in the selling value. I see some of our New Haven County friends shake their heads, but it is gospel truth, gentlemen, and you will find it so by a careful investigation. The blame, I think, rests most largely with the dealers. There is an opportunity, it seems to me, for the growers to work upon the dealers to get them to handle the best grades, because it will be to their financial advantage.

Our pomological society, which has been organized in the State some seven or eight years, has done the most beneficent work along this and other lines. Lines of method of selling and handling, also by making the people in the cities and towns acquainted with what is going on. That is what is necessary. Thus we have at present within our own State developed fruit growers who love their business, fruit growers who believe in fine fruit, and who believe in themselves. I might name over a large number of them. I cannot name

them all, but they are not all like our friend Allen with his grapes. But the development of the business in this State has shown what can be done on the rough and rocky hillside farms that many would say were only fit to be abandoned. Our friend Eddy up at Simsbury has splendid strawberries. His system of propagation and his system of marketing is way ahead of anything, almost, that was ever dreamed of before. He has shown the possibility of an entirely different soil. The man and the means and the fruit and the market are all worked in together harmoniously to the attainment of a grand result. And there's our friend Merriman, and our friend Gold. He says he is hanging on to some old trees upon his place that ought to have been disposed of, but the younger and more energetic people up there are doing a live up-to-date business. That's a case where perhaps the son knows more than the father. And in the peach line, our friend Platt, the pomologist of the society, and his neighbor and friend, Barnes — they have shown the possibility of great results in this line in Connecticut.

There are hundreds of other farmers who are interested in the general lines of agriculture who have seen the possibilities of the soil; seen what can be done for their families, and not only farmers, but men in the towns and villages engaged in other enterprises, who are planting fruit trees upon their places, and are raising grapes, apples, pears, and peaches, and other kinds of fruit. I can think of quite a number of such. I know where a single half acre is earning dividends on a \$3,000 valuation on the land. I suppose they put it in at that price, though the land wasn't worth that. It is returning a good dividend on \$3,000 valuation in the way of home food supply. We are just beginning to think about a good many things in connection with fruit raising. Our old friend Fenwick was troubled with worms among his crop way back in the colonial days, and he thought they would destroy the apple trees, but for 250 years we have just let those creatures go on destroying things right and left. It is a wonder that some of our apple trees have been so good when we consider the neglect with which they have been treated. Witness the old apple tree planted down here in the town of Wethersfield, an old English Pearmain planted in 1650. I believe that originally the tree was brought from England, but possibly was only a scion. That English apple tree down there in the town of

Wethersfield, from 1650 down to now, has gone on bearing fruit for generations, and the owners of the land tell me that it produced considerable fruit this year. Mr. Gold will recollect some of the samples went to the World's Fair, and some of them to other places.

We are just waking up to the fact that we ought to care for our trees and plants and get rid of the insects and noxious pests that infest them. And as to spraying, that is only just beginning. That opens up a wonderfully bright prospect before us, because it assures us that we may control a great many of these troubles which have been so serious in the past. Furthermore, the new style of nursery catalogue has done a great deal to stimulate fruit culture in our State. The production of specialties in trees and plants and vines in great quantities, as I intimated about the grapevines, has also had a great effect in stimulating fruit culture. The same thing as is done with grapes is being done with apples and peaches and pears and plums. Men in distant States, and in our own State, are putting their whole thought and attention on the production of special lines of plants and trees that are best suited to certain conditions, and are producing them in enormous quantities, and the large circulation of horticultural catalogues that are annually sent out has also done a wondrous work to stimulate planting. Some of us are liable to plant a little more than we ought, but that is a question which will regulate itself. The product of that sort of advertising, as in the past, is doing a wonderful work in stimulating fruit growing and the distribution and dissemination of the best modern ideas as to varieties, and as to methods of culture.

Now then, what is the future of Connecticut fruit culture? What is the future to be? It seems to me that with the greater cultivation and refinement of our people which is being talked about everywhere, and which is plainly in evidence in all our public work, and which was alluded to in the able lecture by our good lady friend from Boston last night — the general tendency to cultivation and refinement among our people means a greater consumption of fine fruit. It means, too, that the fruit grower must be up to the demands of the people. It means also that fruit that we are able to sell in these nearby towns cannot possibly be sold in the future. It means that with the growth of refinement and cultivation among our people only the best can be sold, and the growers

of the future are going to do better than we have done. The markets are going to demand better fruit. They are going to demand fruit of a better color and a better quality. It will have to be better packed, and more tastefully displayed upon the market continuously. That is the general tendency of the times. It means that there must be knowledge and skill displayed in the manipulation of the soil, skill in the selection of the plant, skill in pruning, and care and attention and skill all the way along. It means that every farm home is going to devote more land, and that the owners of the farms that are properly managed are going to devote more time, to the production of fine fruit for home supply.

The farm home of the future is not going to be satisfied with a few apples, or apples in their season, or with one small bed of strawberries, but they are going to have fruit very early in the spring and run through until the next. They are going to have it on the table, and have it in the house at any and all times, because it will become an absolute necessity. It is a matter of right living, and just as necessary as it is to take pure water and wash our faces several times a day. We are going to do that, and it is going to give us strength and happiness, and that is one of the demands that is coming upon the farmer. Don't think it is going to be any easier. It is going to be still harder right along. We have got to put so much more thought into these things, as the good lady expressed it last night, that it is going to be harder right along. How much more a person will need to know than we did in the past! People will know more, and have more, and will require more, because they will have more to contend with. And so with progress up the hill. Don't think that life is going to be any easier. It is not. The farmers are going to want better things. They will want better things in their homes and better things on their tables, and in every farm-home we have got to have a better understanding of the fertilization of our trees and plants, and a better understanding of how to attain a most healthful development of plant life. When we have that we shall find that we shall be able to get a better foliage, to produce better fruit. We have got to take up and apply some of the principles which were talked of by Mr. Powell day before yesterday. We have got to know all about these plants which will produce a heavy undergrowth so as not to leave our ground bare in the winter. All of these

things we have got to understand in order to reach the highest success. We have got to have thorough culture at all times. The neglect of the past cannot go on and give any reward to the owner of tree or plant or vine. It is hardly worth while for me now to say anything about irrigation, but there are many soils that require irrigation. That is just as essential as it is to have right methods of draining our soil and carrying off surplus water. We must know how to turn around and bring the water back when it is needed. That is one of the necessities of the best fruit culture of the future.

Then there is the subject of pruning. The pruning which we have done in the past has sometimes been intelligently done, sometimes not. Sometimes it has been woefully wrong, and occasionally partly right. The question of pruning has got to be settled. The training of a tree is as essential to tree life as the training of a child is essential to human life. The training of a little tree, first only a little plant, we have to watch closely in the early years of its growth and start it right, if we are going to expect to compete with the other fellow. And the other fellow is going to get along wonderfully fast.

Then there is the question of thinning the fruit so as to get the most perfect specimens and get the most perfect color. Color has a wonderful deal to do with the value of fruit. First, it is pleasing to the eye, and if it looks well most people think it tastes well. Take two specimens of like quality, one of very fine appearance and the other of imperfect appearance, and the fine appearing specimen will be the most satisfactory to the average digestion. The question of color is important. But we want something beside that in our fruit. Coloring is important, but we want pretty generally to improve the quality as well.

I have seen within the last year some of the famous Japanese plums where the trees were allowed to produce all that they would, and I refer to this as touching upon the question of how the quality of the fruit is affected by thinning — I have seen, as I say, within the last year, a marked evidence of that, especially in connection with Japanese plums. Those trees were allowed to produce all the fruit that they would, and it not only lacked in size and in fine appearance, but also was very inferior in quality, while some of the same variety on similar trees that were thoroughly thinned were not only in-

creased in size and had a better appearance, but were of superb quality.

The quality of fruit sometimes may be increased anywhere from 10 to 50 per cent. by thorough thinning, and quality in fruit is what is going to be in demand, and very largely in demand, in the future. We have not heard so much of it in this State, but I heard it stated at the meeting of the Ohio State Board of Horticulture, and I thought it applied to every grower of the future — that the man who would plant cheap fruit should hide his head in shame. There is money in fruit. If you only desire to benefit your fellow men, plant fine fruit, but if you not only want to benefit your fellow men, but secure good fair reward and satisfaction in the business, grow fine fruit also. The public are appreciating it more and more. The public are more and more ready to pay for it. It seems to me in the future that a large majority of our fruit growers are going to put in less acres, but have a finer quality. By devoting more care and attention to that which they do raise, they are going to expand the demand for fine fruit tremendously. The majority of our fruit growers, I think, you will see cutting down their fruit acres, but toning up the yield and the quality and beauty of their fruit.

The man who has but a moderate number of acres and a moderate capital is the man who is going to devote his own personal attention to the production of fruits; and, so far as that is concerned, the man who wants to devote his own personal attention to the production of fruits, either upon a large or a small scale, is the man who will be successful. He wants to devote his own personal attention to the production of fruits, and the man who does that will be the man that will cut down his acres, and he will cut down the profits of the other fellow, because he will produce such fine fruit that he will take the market that is willing to pay for fine specimens. It seems to me there is a wonderful opportunity in the future for the man who wants to grow fine fruit. I had an opportunity when in New York a while ago of seeing some remarkably fine apples. I took some out of a box, a bushel box that sold, and which was only one of a carload, at \$3 a bushel in the city of New York. And there were other carloads selling at like prices. The specimens that I saw were perfect specimens of apples, not over large, but perfect in form for their

kind. Not a spot or a blemish on them. No chance for worms. Not one in the whole package. The package was absolutely perfect apples, and that bushel sold right in the New York market for \$3. I thought of the possibilities of apple culture, and I thought of the many barrels in this year's crop that were sold for a good deal less. Now there are \$3, and \$2, and \$1 apples, and there will be a market for inferior specimens, but this showed that there was a market for apples at \$3 a bushel, by the carload lot, and it told me what the opportunity was for the cultivator of fine stock.

We can do just as well in Connecticut, but there must be greater care in the grading and packing of our fruit. In the first place there must be a knowledge of what good fruit is. Now, too many of the fruit growers of the past, and too many of the present, have no standard to measure a perfect specimen by. It may be a good specimen of the crop of this year that they make a standard of first quality, or second quality, but there should be a standard which they should try to reach in all seasons. There must be more care and accurate knowledge as to what a first-class specimen is, and then the grading must be carried on according to that knowledge. There is going to be a wonderful opportunity in the future for growers to put up packages of fruit especially for family consumption; an opportunity to put up such sized packages so that they can be sold direct to the consumer, either from your own wagon or through any number of channels that it may go, but so that the fruit shall reach the family home just as it left the farm. There is going to be a wonderful opening there. There are many middle men, and the more you can cut out the middle men in reaching the consumer, the better. You must figure out whether it is cheaper for you to reach your consumers direct, or market your stock through commission men or retail dealers in the towns. That is a question of business. But get at the people direct, and put up a size of package that will be popular, and I believe there is a wonderful opening in that direction.

Another thing that we have to meet is lower prices. Some of the strawberry growers of 1898 don't want to see any lower prices. But the general tendency of everything is toward lower prices. There is a general tendency towards a lower reward for our labor, and we must expect, upon the whole,

lower prices in the future for all of our productions. There is going to be a general lowering of prices all along the line.

The wonderful development of electricity and trolley lines extending over the country is going to be a wonderful help, it seems to me, to the fruit grower of the future. In Ohio last week I noticed that out from the city of Cleveland there are already three trolley lines that cover a distance of forty or fifty miles, and they have already established a plan of local express for the local distribution of the various products that may be needed along the line. Some modification of what they are doing there now, and a general development according to our needs and our possibilities, is going to mean a great deal in the distribution of all farm products by this means. It will mean a distribution direct from the farm to the village or city, or to the consumer. It is a new style of horse and wagon that is going to be of wonderful benefit. Fruit can be gathered from a farm away out in the country fifteen or twenty miles, and with the proper packing and handling can be delivered to your city customer, fresh on his table as when it was gathered. He will have this advantage if he will only pay the price for it. I have a city friend who grows strawberries, and he told me that they cost him sixty cents a quart. Now, there are men along the line that would grow them for him for fifty-five cents, or they would take fifty cents, on a pinch. There is an opportunity.

Cold storage is going in the future to play a large part in our fruit culture, and by cold storage I mean cold storage, and not the cold storage like some of that we have had in the past. I mean cold storage that will be either directly upon the farm, owned and operated by the farmer himself, or neighborhood cold storage which is co-operative, and in which the fruit shall be put within an hour, or half hour, or quarter hour, after it is picked, or just as quick as it possibly can be. Lack of promptness in the care of fruit after it is picked accounts for the loss of a great deal of it. We have picked our fruit, gathered it, and held it for awhile, or we have often carried it to market and tried to sell it, and then when we couldn't get what we wanted for it, we put it in cold storage. Then they said it was not good, and came out in bad shape. With cold storage, we shall be able to gather our fruit and hold it until the market conditions enable us to sell it to the best advantage.

That is one of the important things. I believe in promoting either individual or co-operative cold storage.

The experiment stations have done a world of good for us in the past, and the fruit-growers of the future are going to use them a great deal more. The information which has been imparted by them, if it had been used by the fruit-growers in the past, would have been of wonderful value, but the progressive fruit-grower, one who is looking towards the future, is going to lean pretty heavily, first upon himself, and then upon the information that he can gather from experiment stations. It is hardly possible for any farmer without considerable expense to go into all the various lines of investigation that are needed to successfully combat the many insects and noxious diseases that infest our plants. That is plain enough and needs no argument. I said up at the meeting of the Massachusetts Board of Agriculture that they needn't worry about the San Jose scale, that it never would do one-half of the harm to the apple crop that the codling moth does. Yet it is a hundred times more dangerous. The mere fact that it is more dangerous makes it more safe. Our grandfathers didn't have to fight the codling moth. To be sure we have had eighty or ninety per cent. of damaged goods, but we are satisfied with them. They didn't see the worm itself, and we couldn't and didn't charge them for the lack of something like that. But we have gone on and allowed the codling moth to work havoc in our orchards. We have been so careless that the good Lord said: "I will send you something now that will kill apples," and he sent us this scale, which not only hurts the fruit, but actually destroys the tree.

The successful fruit-grower of the future must be a man who is in love with his business. Thoroughly in love with it. Now, I don't know whether you people know what love means. Thanksgiving I was down in Maryland looking up fruit matters for a friend, and we came to a railroad station. We went in and sat back of the stove, and a young man walked up to the ticket office and handed out his money and bought his ticket. When the agent handed him his change he had quite a number of small bills, which he carefully counted up and then he slipped the change in his pocket and walked away, leaving his ticket. My friend picked up the ticket and following him up, he said: "My friend, you must be a little off. You are a little absent-minded this morning. I guess

you must be in love." "Oh, no," he said, "I am not in love; I am married." I don't know whether you younger people understand this, but perhaps some of you older people may. Now, that is a true statement, and the man seemed absolutely innocent of having said anything at all out of the way. But the successful grower of fruit, whether he gets his ticket or not, he will not have any money to buy a ticket with unless he is in love with his business. Unless he loves to see plants and trees grow. Unless he loves to tend them and give them the care which alone produces the highest results. For such a man there is a great chance for success.

This Pomological Society which I told you of some little time ago has been established in the State for seven years, and the work it has done has been most excellent. It has not only held fall meetings out upon the farms of our various friends, but it has discussed the various problems, and great good has come from these discussions. Last October, for the first time in its history, they held a fruit exhibition in Wallingford. The object lesson that was taught by the apple exhibit there, if it is taken up by the land owners and fruit growers in the State, will, in the future, be worth millions upon millions of dollars to the agriculture of the State. If the State Pomological Society with all its years of work never does anything else, if it is wiped off from the face of the globe, its exhibit of apples at Wallingford last fall, showing as it did the possibilities of the apple in Connecticut soil, when handled along right lines and modern methods, would justify its organization a hundred times over. That exhibit showed the possibilities of the apple in Connecticut in the hands of skilled cultivators. It was simply marvelous. Those who saw it know what it was. The opportunity of seeing such an exhibition of fruit is not often had. There were such perfect specimens of apples; perfect in form, perfect in color, and free from spot or blemish, showing what might be done upon the farms of New England.

The apples exhibited were not from a single town, or a single county, but from various sections of the State. They showed the possibilities of our soil, and in the future it seems to me that there are hundreds and thousands of acres of land which are now idle, now growing up to bushes, that are not pastured at all, land where the valuation is way down to five, ten, and fifteen dollars an acre, land on so-called abandoned farms which is not paying any dividend upon any valuation

whatever, which is going to be reclaimed and planted with apples. The apple orchard of the future, it seems to me, is the greatest hope of this idle land in our State. There is the greatest possibility for it, and there is a great opportunity there for the investment of capital. There is a great opportunity for the intelligent investment of capital, as well as a great opportunity for intelligent labor. I think the opportunities in apple culture in Connecticut in the future are wonderfully bright. I wish I knew there was to be a thousand acres planted next spring, and ten thousand acres the next. It doesn't seem possible that we shall fail to take advantage of this grand opportunity. Whole train loads of apples are being brought in here now from distant States, and while they are smoother and fairer they don't compare in quality and texture to the apples that we grow here. If we plant our idle land to apples we shall add largely to the value of that land. If you are sick and disgusted with agriculture and you want to try a new tack, go down to Brother Hoyt and buy a few fine apple trees, and then, whatever your farm may be, I will warrant you will see the land go up in price. Nothing will increase the value so quickly as planting it with apples. It will be better than selling your farm. When you get your orchard planted and started, you won't want to sell your farm.

Now, Mr. Chairman, I have rambled along on this subject, and perhaps we will get more out of it if we devote the balance of the time to a discussion of the subject by the audience itself.

The CHAIRMAN. You have an opportunity now of plying this man with all the questions you can think of. I have an idea that the more you work a man, the better he is, and we ought to get a great deal of information out of Mr. Hale.

Mr. S. O. BOWEN. I am not a specialist in fruit, but since my acquaintance with Mr. Hale I have taken more interest in the subject. He has got me on the Board of the Pomological Society, where I should not have been unless I had been invited by him. The great obstacle to raising apples in this State has been touched upon by Brother Hale; and that is the moth which has virtually destroyed many of our orchards. Now, it has been my good fortune to visit Storrs College, and

early in the summer when I was there I noticed particularly that the trees presented an appearance of livid green. I asked the question as to what caused that, and they told me it was due to the spraying. And they told me they were just the same throughout the season. Particularly in October and late in September they presented a most beautiful appearance. I never saw such apples in my life. There were perhaps two hundred barrels of them. Some of those apples were on exhibition at Wallingford. Mr. Hale has called your attention to them. Now, I am happy to say that some of those very apples are here in this building, and if you don't believe what he has said, go and see them. Prof. Gulley is present, and I have no doubt, although many of you are familiar with his method of spraying, he would be willing to explain it still further. I was not familiar with it until this present season. I speak of this, hoping that the growers may be interested and go home and do likewise.

The CHAIRMAN. Are there any questions?

Mr. HALE. Right along that line. A man who has but a few apples and but a few plants or vines may think it is unnecessary to do much spraying of his plants, or that to spend his time in that way is unnecessary, but he will find that spraying his trees and plants as often as needed is very valuable. And right here I want to make a suggestion. It seems to me for the present there is a wonderful opportunity for a plant doctor in every neighborhood. That is, in every neighborhood some farmer's boy or girl who will buy or get the necessary spraying outfit and buy all the necessary ingredients for making the various formulas and solutions. There is a good opportunity for them to do neighborhood spraying at so much per tree. There is an opportunity there to do that sort of work. If you appreciate the value that spraying does to your plants and trees, that is, intelligent spraying, you will certainly be willing to pay a plant doctor as well as you do a

cow doctor to take care of your cows, or a horse doctor to care for your horses.

Prof. GULLEY. Mr. Hale's suggestion that he has just referred to opens up the question of the work of spraying in any particular section. Intelligent spraying cannot be done, I think, in that way. Spraying, as a usual thing, has to be done within a short time, and it would be rather difficult for any man to get over a very large amount of territory. That arrangement might work all right for a man to do several farms, but he couldn't take a very large territory. For those trees which he could thoroughly and intelligently spray, I have no doubt it could be made extremely profitable for the man that had his property sprayed. I have no doubt but it might be done in that way to good advantage.

Mr. Bowen has referred to the apples that grew at Storrs, and has said some things about the spraying there. I may say that I do not think that it was the spraying of 1898 alone that produced our crop of apples this year. You all know that in 1896 we had an extraordinary year. In 1895 we began to spray a little, and in '96 we made very thorough work. But last year we had no apples, but we did just as much spraying last year as the year before — I am talking about '97. In '97 we did just as much as we did in '96. In my opinion it is the continued spraying of three or four years that has brought about our great result. In other words, last year we had no fruit, but we continued to spray just the same, and I believe we have seen the benefit of it this year. We had a splendid foliage and it kept the insects down. I think we have more first-class apples than all others in the town of Mansfield, and you know that is one of the large towns, so far as farming is concerned. I think we had more first-class apples, and I believe it was owing to our treatment that our success was due. I am myself a strong believer in spraying, and it unquestionably helps to make good fruit.

Mr. Hale spoke of another point which I think is impor-

tant, and that is, in having a select grading for our apples. One is very apt to select his standard by the best specimen of the year he has his fruit. If that is followed, then a first-class grade would be much better this year than last year, possibly, or next year. I think that is a mistake. I think we can get grades of fruit to use as a standard which would mean the same size nearly every year. That is the only way that one can get in mind an ideal for a standard and carry it from year to year. We must have an idea of what it is and then stick to that ideal and have the same from year to year, and not change the grading in your mind. Otherwise I do not think any person can get a perfect idea of what is an ideal apple. I think that was shown pretty conclusively at Wallingford. Some of the largest apples I ever saw were exhibited there. I think it is a mistake to have a change of grade every year, or of grading in our minds according to the year.

The CHAIRMAN. What determines in your mind the frequency of spraying and the time when spraying should be done?

Prof. GULLEY. In reply to that, I would say that the frequency would depend a little bit on the weather. If it doesn't rain it needn't be so frequent. I am not talking about insects, but particularly for diseases. The time for spraying, as we have had it worked out, has been after the blossoms fall. There is a tendency the last year, in many places where they are working at it, to do it before that and before the leaves are well on. I am myself beginning to believe that perhaps we might spray to advantage at a time when the work was not so pressing and still have it valuable. We spray three times on our apples. We spray once just as soon as the blossoms are off, and then follow that ten days or two weeks afterwards. And then about ten days or two weeks later on. You have got to get around in about once in two weeks. I have not sprayed plums and other stone fruit before the leaves were on, but speaking of apples, I would say that the spraying, in my

opinion, has been the most satisfactory just as the blossoms were dropping, and then two weeks apart after that. Not letting it run over two weeks. I have put it on in a rain-storm and been just as successful as in dry weather, so far as that is concerned. If it once gets well placed in the tree it takes a strong storm to drive it off.

Mr. GOLD. I want to put in a word for one of our old friends that has departed from us, who used to live here in the State of Connecticut, and whose life work we are proud of, Mr. Augur. He exhibited at New Orleans a photo of that great Connecticut growth, the Cheshire apple tree, and a challenge was sent out through the United States to produce evidence of as large an apple tree growing anywhere in the United States. That challenge has not been accepted. It has never been disputed. The great apple tree that stood in Cheshire, which is now no more, as it was blown down by a storm, was undoubtedly the largest apple tree that was ever grown in America. We have the soil and the climate for growing great apple trees, and when we give it an opportunity the apple tree will grow to a size here that is not surpassed by any other section of the country.

The CHAIRMAN. I am a little afraid that Mr. Gold will beat that record if he persists in keeping his old trees.

Mr. GOLD. There are various conditions that conspire to the long life and vigorous growth of the trees. Yet to our native-grown trees that have stood upon the soil from the seed we look for the greatest and most permanent vigor, the longest life, the greatest spread of branch, and the greatest productiveness in bushels of fruit.

The CHAIRMAN. I wanted to ask Prof. Gulley what proportions you use, or what formula, at Storrs for spraying apples.

Prof. GULLEY. Five-five-fifty. That means five pounds of sulphate of copper, five pounds of lime, and fifty gallons of water. I use those proportions, but you don't need quite so much lime. But I use it because it doesn't do any hurt. To

make the Bordeaux mixture I take twenty-five pounds of sulphate of copper and dissolve it in twenty-five gallons of water, hence I have got a pound of copper to every gallon of water.

Also take a bushel of quicklime and slack it in a tub that will hold twenty-five gallons or more of water. Then, having a cask of fifty gallons half full of water, add two pailfuls, about five gallons each, of the copper and lime solution, and stir thoroughly, avoiding any coarse grains of lime. Then fill the cask with water. This for apples and pears; it must be weaker for stone fruit. The Bordeaux is used for diseases alone. For the codling moth, add to the two first sprayings four ounces of paris green to a barrel.

Mr. BOWEN. I don't mean to interrupt this branch of the subject, but I regard another branch as very important, and that is pruning. A few years ago friend Hoyt here in Hartford, at one of these meetings, exemplified his manner of pruning trees. He took a very handsome specimen of peach tree, and I thought he ruined it. He showed how he would prune it, and it was certainly heroic treatment, to say the least. I hardly believed in it then, but in a visit to California last winter I had an opportunity to visit a great many of their fruit orchards and groves, and I noticed that it was the almost universal custom to prune their trees even more than he did. Now, I have been told that heroic pruning is apt to destroy or injure the longevity of the tree. You couldn't expect it to live very long if you trimmed it very hard in its early years. I thought of that subject when you were speaking of that antiquated tree out here in Cheshire, and I would like to know if anyone knows whether that tree has been pruned very severely or not. Perhaps there is no one who knows anything about its early history.

Mr. GOLD. Mr. Platt has lived very near the great Cheshire apple tree.

Mr. PLATT. I saw that tree when it was in its prime. And saw it just after it had fallen with decay. I don't sup-

pose it was ever pruned at all, or if it was it was to get rid of long, low branches. It stood in the dooryard of a house, nearly in front. The branches were up out of a man's reach, above a horse's head. It may have been trimmed in that way, but I don't know. I don't think it was.

Mr. HALE. The question comes right here, What are you pruning your apple trees for? Fruit or shade? If you want shade trees or ornamental trees, the white oak will last longer than the apple, and the elm and the maple and other beautiful trees are what we want to adorn our grounds with. If pruning does tend to fruitfulness, it does tend to the injury of the tree or plant and shorten its life, but anything that tends to shorten the life of the tree tends to fruitfulness. It seems to be a provision of nature that the wounding process or the injury of a plant tends to induce it to leave some seed behind before it dies. Pruning does stimulate fruitfulness, and that is what we are after. We are after the greatest amount of utility and profit. And if pruning your apples, by a close pruning you bring them into bearing, and you get a tremendous lot of fruit before other trees come into bearing. I believe in close pruning, and in having the trees set at correct distance apart. Right planting and right pruning will give the best fruit results, and that is what we are after.

Speaking of apple culture and the possibilities of the cash return from same, I recall to mind a trip which I made two years ago. I was called to Pennsylvania to meet a gentleman out there who was a very wealthy man. He became so from mining and manufacturing operations, and as he accumulated his money he has been putting it away in various investments. He has three investments. He is a millionaire. One of his investments was in government bonds, one in farm lands, and the other I have forgotten. I think insurance. He has been buying farm lands in Pennsylvania for the last twenty-five years. He has bought thousands of acres. He has cultivated them with the average farm crops. He has

been raising corn and wheat, and the average farm crops, and some little fruit, but corn and wheat and clover have been the principal products of the farm. He told me that from his experience of a series of years, speaking of his investment as a matter of business, his average net income has been about six per cent. on his investments in farm lands. His net income has never been below three and one-half on any one farm, but the average net income has been about six per cent., or nearly twice as good as a government bond at the present time.

But he is thinking ahead, and he wanted to talk about planting a part of one of these farms in chestnuts. Some of you know, perhaps, of the chestnut grafting that is going on up the Susquehanna River, and this year it has given some magnificent results. Some of the rough hillsides have borne a crop of nuts this year worth almost ten times the value of the land itself. This is one of his business ideas. He thinks it will pay better. Another portion of his farm he is going to put into a hundred acres of apples. There is a business man who is investing his money along business lines, yet he is not a farmer himself. His other business takes up his attention, but as a business investment he is putting his money in this way into agriculture. I brought along these samples of chestnuts to show what can be done by chestnut grafting. Chestnut grafting is going on in Connecticut. If you pick open that little burr you will see it contains some large specimens. Ordinarily, you wouldn't look at that little burr, it is so small, but there is very little burr to it, it is all nut. There are two tremendous chestnuts in that burr which can be obtained by this process of grafting which is now going on. (Mr. Hale exhibits to the audience several burrs containing the nuts referred to by him.)

There is another variety of a cultivated chestnut obtained by grafting on the native chestnut stock. It is as sweet as our best native chestnut, and yet almost three or four times the size. Here is another variety. It is a fine large nut, of

which there are hundreds and thousands imported from foreign countries to be used in our market that are not sweet at all — with no sugar in them at all. Those of you that know about the grafting of the native stock know what a demand there is for good nuts in the market. You know how readily the people buy them, and boil them, and roast them, and chew them. Yet here in Connecticut we have got a lot of cheap land on which just the chestnut timber is growing, which we can use to produce these nuts. There is some of this land on which the native chestnut stock stands that after the timber is cut off and sold to the railroads it would not be worth three dollars an acre, yet it might be grafted with these improved nuts and made to yield an income which would be equal to the value of a good many hundreds of acres. That is one of the possibilities of our soil. That is a possibility that a sharp business man in Pennsylvania sees, and he is acting upon it. That is one of the possibilities of Connecticut's future.

QUESTION. Can they be readily grafted by the ordinary man?

MR. HALE. No, sir. They don't graft as readily as apples. There is nobody that knows very much about chestnut grafting. It is in an experimental stage. But the most successful grafters in the mountains of Maryland, and the few that have tried it in this country, have found that the smaller the stock is, a little sprout, or a little seedling that is not larger than your finger, is the most successful. It is more successful than the larger stock. It has done better. It has been done to a considerable extent here in this State, and, as I understand, the best success has been attained where the stock or scion are of small size. I think that Prof. Britton has made quite a series of graftings and is gathering information for us. I think he can tell what has been done in the State, and perhaps he can tell you more about that than I can. As a matter of fact, he and no one else absolutely knows yet very much about what the right course is.

The CHAIRMAN. Where do you get your scions?

Mr. HALE. The scions are being sold by growers in Pennsylvania of the various nuts, and are quite expensive.

QUESTION. What is the proper time to do the grafting?

Mr. HALE. In the spring, after the stock begins to grow. They seem to decide that the proper time is after the stocks are in full bud, even leaved out, they succeed better.

The CHAIRMAN. Will Prof. Britton tell us something about this?

Prof. BRITTON. Mr. Chairman, on this line I will say that during the past season I have had something over two hundred grafts representing five or six different varieties of chestnuts. Some of these were Japanese and of the European species. These I set in stock of our native American chestnut, some in the tips of large trees, others in tall sprouts and seedlings which have come up from the ground. My experience has been that the scions take a little better in small sprouts, where a better union is obtained than where the cleft graft is employed. Most of the cleft grafts where they were made in the spring took very well. Nearly all of them began to grow, but some were killed later on by the drought which we had last season. I am well satisfied that it was the drought that killed them. Others made a large growth and were broken off by the wind. But the grafts which were set as early as the 20th of April, and from that to the 20th of May, last season, did the best. That was the time that the scions began to grow. Some were set as late as the 20th of June. That was after the chestnuts were in full leaf. These took about as well as any, but they made very little growth. The growth was weak. In some cases only an inch or two for the season. From one year's experience, I should think that the proper time to set the scions in Connecticut would be somewhere from the middle of May to the first of June. A few days either side makes no difference. In many cases where the cleft graft is employed with large stock the union is poor. I can

confirm what has been said in regard to the greatest success being obtained by using small stocks. If the splice graft is used, I think the union will be better than if the cleft graft is employed. From what I can gather, I think that most cultivators are fortunate to get much over fifty per cent. of their grafts to live and grow. Of course I was trying it in an experimental way. I tried several different forms of grafting, and at several different times, and the result for the whole season is somewhat less than fifty per cent. which are now alive. That is not counting the ones that have been broken off. I merely mean those which are considered dead. About fifty per cent. are now living. In this State those that were put out about the middle of May, the larger percentage are living in most cases.

QUESTION. Have you tried grafting or setting scions under ground?

Prof. BRITTON. No, I have not. My grafting was entirely above ground.

The CHAIRMAN. I would like to inquire if there is anyone in the audience that has ever grafted walnuts and had them grow? My nearest neighbor has done it repeatedly. I have seen him. He didn't tell me that he had the least trouble at all.

QUESTION. How did he do it?

The CHAIRMAN. I cannot tell you. But I can show you the trees. He has two trees that I remember distinctly. They have been bearing for several years.

Mr. JEFFREYS. On this question of walnut tree grafting, I would like to hear from somebody else that has had better luck than I have. Somebody who has had better luck than I have better try it.

Mr. BOOTH. I think that Mr. Hale said in his interesting lecture that Boston was a better market than New York. I wish he would say why it is that it is a better market than Greater New York. The latter has about six times the in-

habitants and is a much larger city. I should like to know why it is that Boston is a better market than that locality.

MR. HALE. Now, as to why Boston market is so good. I would say it is the people. That tells the whole story. It is the cultivation and refinement and æsthetic tastes of Boston; that is what it is. It is the people. It is the people of Connecticut. The people of little old New England with their finer perceptions of the finer things of life make this north-east corner of the United States the best fruit market in the world.

THE CHAIRMAN. There is another feature about the New York market which any of you who are conversant with it at all know to be a fact. If there is any place on the face of the earth that is a dumping ground, New York is that place. If you have got anything to sell, you can sell it in New York at some price. If you have got a poor stock of apples, you can sell them there at some price. There are a great many poor men there, and they hardly know what they eat.

MR. ———. I would like to ask Mr. Hale what he uses in his grafting.

MR. HALE. I use wax in all of my tree grafting. A wax which is made by using four pounds of rosin, which, after being melted, has added to it one pound of tallow. This has worked very well, indeed. In making splice grafts, of course, I have to tie them in order to keep them in place. I like the wax which I make after this formula; it is better than anything that I can buy. I never have any trouble on account of brittleness.

QUESTION. I would like to ask Brother Hale if he has ever set any Columbia raspberries? It is a comparatively new variety and a variety that is worthy of attention. I would like to ask him if he has had any experience with them.

MR. HALE. I have had it ever since its introduction. It has a very strong growth. The berry is a little light in color, compared with some varieties. It is a cross between a red

and black. The vine may be a little more rank in growing, and the berry is a little brighter in color, but it is very similar to the Shaffer. That is practically what it is.

Convention adjourned to 2 P. M.

AFTERNOON SESSION.

Thursday, December 15, 1898.

Convention called to order at 2 P. M., Mr. Seeley of Roxbury in the Chair.

The CHAIRMAN. The subject is "Fruit Culture, Orchards and Small Fruits." I have the pleasure of introducing Mr. George T. Powell of Ghent, N. Y.

FRUIT CULTURE. ORCHARDS AND SMALL FRUITS.

HON. GEORGE T. POWELL, GHENT, N. Y.

Mr. Chairman, Ladies, and Gentlemen: The question which is announced this afternoon covers a very broad field. I know that my friend Mr. Hale, who preceded me this morning, in his horticultural operations, has covered a very wide territory, and I can imagine something of the ground that he must have gone over this morning. Hence I imagine that he has brought you up to the point where you have to consider what is before us in the way of competition. And so I want to strike directly into the question of conditions which we have got to bring to our orcharding in the future if we are to meet with definite and satisfactory success. I believe it is true of the State of Connecticut, as it is of my own State, that one of the woeful needs of the present time in orchard management is a high system of tillage or cultivation.

We need far greater care in all the details of management of our orchards. I believe that is the great need in this State, as I know it is an imperative need in the State of New York. I believe we have not considered sufficiently what tillage means. Now the idea in the minds of most men is that tillage is simply the keeping down of weeds. Well, in that respect, weeds are not the greatest blessing that comes to a farmer, but they do force him into the fields when otherwise he wouldn't

be seen there. Hence, while it is important to keep down weeds, it is by no means the primary object of tillage. If we are to meet the conditions of our trees, and we are to improve the quality of our fruit, we must begin at the foundation. We must begin with the soil upon which these trees are standing. And here comes the very vital question for us to consider and understand, for in thorough tillage lies one of the strongest factors of improvement that we can bring to our orchard management.

We want to remember, fruit-growers, and I take it this afternoon there are a great many fruit-growers in this audience,— that we have for two hundred years been taking out of our soil productions that have gone to build up the wealth of our great nation, in cereals, in vast quantities of hay, in enormous productions of potatoes, all of which have been drawing from the soil the very elements essential to healthy trees and fine qualities of fruit. Now we have been drawing upon the stores of potash in our soil, and tillage is one of the most economical means to supply our fruit with that needed plant food. I want to say in addition to this — and I must pass over this very rapidly, for I cannot dwell very long on any one point, and hence I can give only a few suggestions along various lines of what has been gained as the result of careful study, and which I feel it is the most imperative to give this afternoon.

Now, in addition to tillage, which in a word means making a more liberal supply of plant food available to the roots of our trees, comes the very vital question of the use and handling of the moisture of the soil. I know our brother Hale has gone right into the matter of supplying this through irrigation, but you cannot all do that. We have not all got an available water supply, and hence where that is not possible tillage comes right in here to supply by other methods the water and moisture needed in the soil by its more proper use and conservation. So tillage is very important to us in its relation to moisture. We lose immensely by the rough system by which we handle our land in the loss of moisture. In some seasons we do not begin to get a sufficient rainfall to produce a crop, and if we were dependent upon the rainfall that comes during that season we should fail absolutely. Now our success lies in the amount of moisture that is stored up, and our success will depend upon the manner in which we conserve that mois-

ture in the soil for the use of our plants. Now I want to give you, as briefly as possible, a little illustration of how this thing works.

We will take, for instance, a strip of soil and leave it undisturbed or partially disturbed. Now we shall find that there will be an immense loss of moisture during the growing season. But if we disturb that soil properly we can hold back much of that moisture. You all know how water percolates through soil. It is not necessary for me to explain about that. Now then, one of the objects of tillage is to so hold and conserve this moisture that we are going to get the benefit of it for our plants. We will take for illustration the forward movement of water which has accumulated in the soil and through the growing season more rapidly passes off into the atmosphere. Now, one of the great advantages of tillage is to so control that moisture we are passing out through our plants as not to waste it. Now, tillage should be constant from the time of the first opening of spring, and hence our machinery should be running continuously through our orchards. We all know that we have suffered during the past fifteen years a great deal in New England farming. We have suffered more than I can say from this cause than from any other cause. I mean from drought, and yet I believe it has been possible any time during the last fifteen years, when we have been suffering from drought, for us to have reduced by fifty per cent. our loss by this system of tillage which I will give you just as rapidly as possible.

What is tillage? As we understand this forward movement, which is constantly going on in all trees, it is always towards the surface. The moisture is constantly working out in that way. If we can understand the philosophy of tillage we shall conserve and hold that moisture so it will do us immense good even in the dry season. So the reasons for running cultivators and such implements in our orchards is to cut off all of this communication which is going on, forward from the soil to the surface, to the atmosphere, and if we succeed in stopping it then we have solved one of the most important problems. Now take, for instance, trees. Suppose we have an orchard and we have trees taking up an immense amount of moisture. They require it. You will see that that is the case when you come to study their root system. Now then, if we can cut off by this cultivation all these outlets so closely

we cut off the possible escape of this moisture through the soil, and we leave it there so that it may seek its avenue of escape through the trees, which is where we want it. Hence it can be seen that we are going to carry these trees through a dry season far more successfully than if the moisture of the soil is wasted by being allowed to escape into the atmosphere through these other channels, and we shall have a larger quantity of fruit than we would have if we allowed the vitality of the soil or this very essential element of the soil to escape. Now I know this from experience. While I have not been able to utilize surface water or gutter water in times of drought, I have been able to carry through several crops by this principle of tillage that have suffered very little indeed for the want of moisture.

Now, the next point in our system of soil management is that we want to reincorporate in the soil those elements which we have lost during two centuries of cultivation in its organic matter. While we have been taking out millions of dollars worth of cereals and other productions we have not worn out or exhausted the soil. But we have taken out to a great extent one or more of the most important elements of its organic matter. So the next point which I would make in the more intelligent handling of eastern land where water is not so plentiful as it is in the far west, . . . the next point would be to re-incorporate anew this lost material, so that we can still further hold and control the moisture.

I apprehend we are not to have a repetition of last year nor that of 1896. I apprehend we are rather likely to go to the other extreme. It has been our history for years, and it should be our policy, to begin on the basis of a dry season. No matter whether we get it or not, we ought to start out on the theory that we are going to have a dry season, and then you are all right if it comes. I want to say that it has been my experience, and I prefer a dry season over a wet one. I can control absolutely this condition of its dryness, but when the heavens open as they have for the last two years I cannot cope with them. That is a condition which is too great for us to cope with. He tackles a tremendous big job who ever attempts it.

I prefer a dry season because there is a power in our possession to control and arrest the loss of moisture from the soil, but we cannot control the heavy downpours of rain that we

have had for the last two years. So you see when you cut off this communication from the soil to the atmosphere by running this cultivator over our orchards we are doing several things. We are putting that soil in condition to furnish the plant food that is abundantly there. Our soil is by no means exhausted. We have nowhere reached that point where there is a total exhaustion of the soil. Why, for a thousand years to come you couldn't exhaust your soil, and here in Connecticut and anywhere in these New England States we have got soil as everlasting as the hills themselves. You cannot exhaust the soil. You can deplete it, but by a more intelligent system of tillage you can build up that depletion and you can set free more easily the elements which are needed which are still there abundantly in the soil. So this system of tillage is constantly making available more plant food, and we have gained it by cutting off the water waste.

Now, the manner in which we can reinvigorate the soil I want to give you from my own experience, because what a man has done himself that he knows others can do. I commenced five years ago on a system; yes, seven years ago, on a system of re-incorporation of vegetable matter in the soil. I began first with buckwheat, then with rye. Then I took a system that would not only give back vegetable matter, but at the same time build it up with the very important element of plant food, and that was nitrogen. So, as I studied the value of clover, I began to use that. Then I began to study the differences in clover, and I found a wonderful advantage in my experience in using crimson clover. No doubt you have heard a great deal about it. The experiment station has been doing good work in testing it in your State. I speak of the value of crimson clover because of its special adaptation to use along this orchard cultivation. Now, crimson clover is not better than red, but it has this peculiarity of being an annual plant, while the red clover is a biennial plant. You can utilize an annual plant because of its habit of more rapid growth. Hence its adaptability in orchard culture. We can use that much later in the season, when we have finished the important work of tillage. When we have gone all through this process, through the growing season; the season when we cannot have any other plant upon it. It begins the season later, and you can get a more rapid growth and so accomplish the purpose you want of it. I have used it for five years and I want to give you the

result. The results that have been established by my own experience. Results that explain to me things that I didn't know before. I couldn't tell exactly until a scientific man had accurately determined what had been done, so I had the soil analyzed to see exactly what had been done. So in this work there is no guesswork about it. Now, here is the result of three years' work with crimson clover in my orchard, and shows you exactly what has been accomplished.

I had, in common with most of you, a very unusual experience in regard to this subject which I have been asked to speak on. I suffered from attacks of one of the worst insects that ever struck this country, and that is the pear Psylla. I think I dread the pear Psylla more than the San Jose scale. I think I could handle the San Jose scale. I was pretty near the point of giving up after seven years of the hardest kind of fighting in my life. I have pretty nearly surrendered to the parasite. But I have always been a fighter along these lines. I hate to be beaten. And I am reminded just at this moment of Dr. Lintner, one of the best men we ever had in the State. He said a gentleman came into his office one day to get some advice about a little cucumber bug. He says: "I have a garden. I don't care so much about the value of my cucumbers, but there is one thing I do hate, and that is to give up to the little striped cuss. I hate to have him beat me." And so I hated to give up and be vanquished by so little a matter as this pear Psylla.

My orchard had been stripped of fruitage by this insect, and so I began a system of tillage in the cultivation and improvement of the soil, thinking perhaps by a greater vigor of tree life it might help me in this fight against this pest. Now for six years prior to the time that this clover was put into this orchard there was not a pound of fertilizer put upon the land. Then I started in, first with rye. I plowed under the crop of rye. I plowed under a crop that was nearly five feet in height, and then we passed over it and had it all rolled under. The next year I followed with crimson clover, and for three years the land was sown at the rate of ten or twelve pounds to the acre, along the second week in July, and it grew from that time until winter. It usually went through the winter all right. The next spring I plowed it right down as quickly as I could. Now you have the system which we pursued for

three successive years. Of course during the summer the cultivation ceased and then we put on the clover and the next spring plowed under a growth of this clover. Now for the result. That is what you want.

A chemist who was assisting me in conducting horticultural classes in New York State, after listening to the results which were being obtained by the use of this clover, said to me one day: "Do you know positively that you are adding nitrogen to your soil?" Well, I said I knew as well as I knew anything that I was. "I am getting the result." "Well," he said, "have you any idea how much?" "No," I said, "I can't tell anything about that," and then he said: "I will analyze that soil and tell you exactly what you have accomplished." And so samples were taken for the purpose of making this test, and I believe the result is of great value to fruit-growers. We took the samples of soil similar in condition, except that upon one sample no clover had been sown whatever. It was from an orchard just over the fence. It was the same kind of soil, but not under the same general treatment, and then we took the other sample from the orchard. When he came to receive these two samples he found in my own soil, where three crops had been plowed in, first, on the test for water, fifteen per cent. in the clover-treated soil, and 8.75 per cent. in the other. Almost double the water contained in this soil where the clover had been turned under for three years. Now what does that mean? These figures, 6.25, in these two soils makes very nearly forty-seven tons of water more to the acre. These samples were taken at a depth of six inches. That is about as deep as we cultivate in these orchards. Now there is a scientific man's statement of exactly the result which I had realized in the process of carrying through this system. That is what had carried through the crop in dry seasons successfully.

Now the next point. I found in the clover-treated soil a very large percentage of nitrogen, while in the other it was not so great. Here, then, was another difference, showing that the clover-treated soil contained the greatest amount of nitrogen. What does that mean? From the figures it showed a difference of nine per cent. of nitrogen in these two soils. It means that in three years there were 1,350 pounds more of nitrogen added to this soil treated with clover than there was to the other. Now, then, what would that cost to

purchase, figuring the cost of the nitrogen at fifteen cents per pound, which is a less price than it can be bought for anywhere? So the chemist figured out, upon the basis of this lowest price of fifteen cents per pound, to see what the cost would be, and he found that it would have cost me \$202.50. I would have had to put my hand in my pocket and purchased for every acre of land an amount of nitrogen equal to \$202.50 per acre. Now that is a pretty heavy application of nitrogen. Not many of us would be willing to spend any such amount to apply to our orchards. Yet that clover put it there. That is demonstrated.

Prof. Sanborn said yesterday, in the New Hampshire Board of Agriculture, that a number of years ago a German chemist did exactly this kind of work in Germany, and scientific men have always questioned his figures. Prof. Sanborn said that here was an exemplification of the correctness of the German chemist's figures right here in our own country, and demonstrated upon the farm itself. And he said when another chemist demonstrates the same thing in his work that was done years ago, there is no questioning the results, because the work of the scientific man is accurate.

Now, another point. Another very important thing was revealed, and that is, we found in the matter of phosphoric acid, the chemist found as available here 15,000 pounds in this sample of the clover-treated soil, against 8,000 in the other. Figures almost double again. Now, then, these are most important figures to us, showing that we have reached a point where we must improve our system and the handling of the soil. We are in times of low prices of every product now. We have got but little money to do it with. We have got but little money to spend in the improvement of soil, and yet just at this time here comes a principle that is inexpensive, and we can apply it and build up our soil wonderfully. So I speak this afternoon of the importance of the new idea in tillage. We must bring tillage to the aid of our plants. If we can utilize, after we have got through cultivating, if we can utilize some such system as this it will benefit our orchards wonderfully. Now we have reached a point where it is possible for us to keep on in this line of production for years and generations to come and have our soil grow better every year that we are cultivating it. How many of you believe it? But I believe it is possible. I believe it is possible for us to take out

of the soil as much as we have, and more, too, and yet that soil improve and be better upon our hands after we have done this than it was before. But we must use our best intelligence and skill in co-operating with nature so that we can bring about this very great possibility. Now so much for the handling of the soil and for a more intelligent and for a far better system of soil management. When I see our rough orcharding to-day and see the rough condition in which our orchards are left, I wonder how long it will be before our people will turn to this more intelligent manner, and just manner, of treating our soil. Now I must leave this question. If there are any special questions that you want to call up, the opportunity will be furnished.

A MEMBER. What about the potash in the soil? I see you have nothing to say in regard to potash. Was that included in that experiment?

Mr. POWELL. The potash result has not yet been given to me by the chemist. He is now working on the potash end of it. I shall get the potash results, undoubtedly, during the next two months.

Mr. HALE. You speak of plowing in your clover as early in the spring as possible. Why don't you wait and get that wonderful spring growth that would come in five or six weeks after early spring?

Mr. POWELL. That is the question that confronted me right in the beginning in the management of this plan. I brought these samples of the plant with me. I have something like eighty acres at the present time covered with crimson clover. I have sown it in the most inauspicious years. When the seed was sown for this plant it was raining so continuously that I thought there was no prospect of it letting up. There seemed to be no possibility of ever cultivating the seed in, and I went out and sowed that seed myself over quite a number of acres of land. And here is the plant that I got even under those unfavorable conditions. I have got something like eighty acres of growth represented by the plant here. Now these roots, of course, are dry, but the sample will

still show what I want to illustrate. You will notice from this sample that its roots are finer than red clover, that, being a biennial, runs its roots down. It is a deep-rooted plant, and hence it goes down deep and draws up its water and plant food from the subsoil. But this is a fibrous-rooted plant. This throws out a great mass of fine roots. Now, then, to answer your question. I do not want that plant to stand in there any longer in the spring than I can possibly get it under, for the reason that those millions and tens of millions of roots begin at once, as quick as the plant begins to grow, to pump the water out of the soil, and you have got ten million little pumps in an acre passing your water off just where I don't want it. What we are trying to do is to hold the water back. We are trying to hold that moisture down here and keep it right at the surface. That is the reason I plow it under. I want to hold back all the water that has been accumulating from the previous autumn and winter and during the spring. I want to hold back all I can, so under goes this plant just as soon as it is fit to plow under in the spring.

QUESTION. What kind of soil do you have?

MR. POWELL. It is not a limestone, yet there must be limestone elements in it. It is a loamy soil, not sandy loam, somewhat porous, but there is enough of the loamy element to make it a good solid soil. But no matter whether it was heavy or light soil I should want to plow the clover under in the spring in order to hold that water down in the subsoil, and I would do that, especially if it was a light soil.

QUESTION. What season of the year do you think it is best to do this?

MR. POWELL. I make this distinction: So many are prejudiced against crimson clover. They say they cannot get it through the winter. Now I can get this growth, and of course this is a fall growth, but if I can get this growth in the fall I care very little about the winter after that. I care little what the winter is. I would rather not have it freeze out, of

course; I would rather have a covering for my soil during the winter. Naked soil is poor soil in the spring following. Prof. Phillips reminded me yesterday of a very important illustration which he said he wished I would use in this connection. In Minnesota they have found in growing wheat that their yield has been running right down. They have found by analysis of the soil that the growing of wheat did not take out one-tenth of the plant food required in the growth of the plant. Then the question arose, what has become of the other nine-tenths? That was a very important question which they asked themselves at the Minnesota Experiment Station. They finally came to the conclusion that their system of growing spring wheat, which leaves their ground naked, was really the cause of the loss, and was the cause of the loss of power in their soil. Now I would rather have this plant go through the winter without freezing out if I could, but if it does freeze out you have got your elements of plant food there in your soil. You should keep in mind the distinction which ought to be made here, and that is, the fact that this is a summer-grown plant, not to be carried through the winter to the next spring. If you keep that in mind you will not be disappointed.

QUESTION. At what time do you get in the seed?

Mr. POWELL. After the season's growth of our trees, usually. Then we can work in the orchards to good advantage. It will grow better to sow after the middle of July or by the middle, anyway, than it will earlier. It is a cool weather plant, and hence it will grow better to sow when all cultivation ceases in our orchards.

QUESTION. How many pounds to the acre do you put on?

Mr. POWELL. From ten to twelve. I have sown ten and got a splendid covering. I have no doubt that many failures come from the fact that imported seed is used. It is not worth the time to scatter it upon the land. It comes from Italy and from Spain, and from Turkey, even. The crimson

clover is attacked seriously by a fungus which weakens the vitality of its seed, and when we bring that imported seed here it has not vitality enough to do well in our climate. It will often fail absolutely to make any growth. Sometimes it will grow an inch high, and sometimes two inches, and the farmers become discouraged. Get seed grown in our own country. It is stronger in vitality, and you will get much better success by using home grown seed. You are almost sure of certain failure if you use the imported seed.

QUESTION. Where do you get it? Where is it grown in this country?

MR. POWELL. It is grown in great quantities in New Jersey, Delaware, and Virginia. One of the misfortunes of the situation, I must say, is this: The demand for the seed has become so great that some of the dealers are importing the seed and selling it as home grown. So you see we are in a bad fix. But I would say this, while I do not propose to advertise anybody or any firm, there are many of you who are Grangers, and as Grangers you can buy through certain sources which you know about which will furnish you good seed. You go to some of the firms that furnish you seed, or that you buy machinery of, and you say to these firms that you want home grown crimson clover and I think you will get what you want. Be sure to ask where you buy your seed for the home grown seed. You can get it where you get your grain supplies.

QUESTION. Would there be any advantage in allowing one acre to ripen?

MR. POWELL. That would not help us any in our orchard work.

QUESTION. What is the cost in bags?

MR. POWELL. Last year I purchased at \$2.50 per bushel. I have often bought the same seed as low as \$2. When your orchards reach their bearing point, then it will pay to make an extra application of phosphoric acid and potash. So I would

say when your orchards are coming into bearing, that an application of from two hundred and fifty to one thousand pounds per acre, and at least one-half that quantity, will be helpful. I don't believe you want to pay one single dollar for nitrogen as long as you live. Put your money into potash and let your nitrogen come by the application of this principle which I have been explaining to you.

QUESTION. Is there any danger of overdoing this good thing, and getting too much moisture into the soil? I saw a peach orchard where a man was taking that view of it.

MR. POWELL. There is where you want to use caution; in a peach orchard. As we understand the character of a peach tree, that will not bear too much nitrogen. But I think that the soil should be cultivated to such an extent as to put your soil in the best mechanical condition where it needs improving. I would use this crimson clover once in two years, for instance, or once in three years, but I shouldn't continue to use crimson clover in a young peach orchard. I would make an exception, of course, in peach culture. Make an exception again in grape culture, but you do not want to stimulate too much wood growth. For apples and pears and plums and other fruit, I think there is no danger of overdoing this among your orchards in a good many years.

QUESTION. I have grown crimson clover here in Connecticut for three years. You say it is better to be plowed in, and I agree to that. I have not plowed it in between raspberries, because I was afraid of cutting the roots. We have worked it in a little. Would that answer?

MR. POWELL. It becomes incorporated in your soil. It would not be wise to put your plow on and plow it as deeply as you would have to, but if you destroy the growth it causes the accumulation in the soil of the elements which I have referred to.

QUESTION. How much benefit will it be to sow with buckwheat, and what advantage will it be after the buckwheat is removed through the winter?

Mr. POWELL. After your buckwheat is cut, then it begins to grow, and it makes a very good covering before winter.

QUESTION. Won't the buckwheat kill it? I never saw anything but what buckwheat would kill.

Mr. POWELL. No. It will be very small. It will not make a big growth, I grant you, with the buckwheat until it is cut; and then it begins to grow, not before. So you get quite a benefit during the balance of the season.

Now the time is passing rapidly, and I want to take up one or two other points. I want to speak of the treatment of trees when we plant them. We could profitably spend this whole afternoon upon this subject alone. It is important enough. We cannot always get together like this, and I want to give you one or two other points in connection with orchard management. I believe we fail very much indeed in the most successful handling of our trees. Now the nurseryman always has heaped upon him a load of curses that don't belong to him. I want to say this for the nurserymen of our country: I believe there is no better or truer type of men than the nurserymen of our country. I speak of this matter because I know it is a fact. I never attend a gathering of nurserymen in the state of New York but I have found an exceedingly fine body of men brought together.

I believe that the nurserymen, as a rule, aim to grow honest trees, good trees, and benefit those to whom they sell their trees; yet there is no class of men who receive more curses, more criticism, and more unjust criticism than the nurserymen. So I want to say this from the beginning, that when a man buys a bill of trees the nurseryman's responsibility ceases. When the nurseryman receives that order and ships it conscientiously, shipping a good class of trees of the kind that has been ordered, that are well grown and put up in good condition, his responsibility ceases, and the responsibility of the buyer begins. When he receives those trees he ought to know that it is his duty to put them in proper

shape for planting. But here is where failure is had all along the line. In the first place many trees are planted just as they are shipped. Now that is not the proper way of handling trees. The process of digging naturally disturbs the roots. It is all the nurserymen can attend to to fill the order and get them off in good condition.

Now, what is the first thing to be done when the buyer receives a bill of trees? We will say that this box of trees has been received, perhaps a hundred, or perhaps two hundred, and there is no reason why those trees when set out should not every one of them turn out well. Suppose they are apple trees. The principle will apply to all. There is no reason why every single one of those apple trees ought not to be alive, and, if properly cared for, be in good condition seventy-five years afterwards. There is no reason at all why that should not be the case in our climate and with our soil. Now then, when these trees come to us, their roots are more or less broken or cut. There is no help for that. If they were not we should at least go on and reduce these roots to a certain extent. They are not in condition for planting. They are more or less dry on the ends, and are at least in no condition to grow. Hence, the first duty of the buyer is to take those trees and put them in shape.

Prune your roots carefully. Prune your roots for the reason that you want that tree to start and grow again. Its relations with the ground have been sundered. It has been torn out and broken up, and before that tree can ever be a live tree again, it must arrange itself in the soil. Now that calls for pruning for that reason. I will indicate just where the pruning must be done. At least take off from one-quarter to one-third of the roots, for the reason that before that tree can ever grow again, it must re-establish a new root system. In these roots will be stored up material. In your roots are stored up material for this process of re-establishing itself. Now, if your roots are broken and torn more or less, they can-

not do that thing so well, hence we prune with reference to assisting that tree to throw out a new root system. That is the object. It is not a case of too much or too little, or anything like that, but we want to help that tree to re-establish itself. Now what is the philosophy of that? If you can dig down to the roots of your tree, you will be surprised to see with proper treatment how quickly that tree has pushed out a new lot of roots, and how quickly that tree has begun to respond and go on again and grow. It depends upon this whether you are going to have success and whether that tree is going to stand and live, or whether it is going to be destroyed the first year. If it dies, then woe be to the nurseryman. He is the man that is responsible. A great many do die for the reason that they are not fitted so that they can quickly re-establish themselves again in the soil. Now what will be the effect of this root pruning? You will get exactly this condition. Every man who has ever examined or dug up one the following season will find the soil completely filled with just that formation. And the moment it takes place away goes the tree. It is certain to grow. Now, if you give them that training and this root pruning, your tree is almost certain to grow. Now, I reduce the top of the tree.

(Mr. Powell illustrates upon the blackboard.)

If that is a peach tree, of course you peach-growers know all about that and understand the object of it. I bring that tree right down. Cut it right straight back. You are helping the tree by this operation. That tree is going to get hold of the soil and get its root system established, and you will have a far finer tree by close cutting. Now, if it is an apple tree, I would leave a little more. I would put that little tree first in this shape, or, if it is a pear tree, I would leave it in that shape. Cherry trees will not bear the severe training and pruning that others do. Shape the top of your cherry tree when you put it out. Don't change it over much afterwards. Now, why is this done? For two reasons: I want

to reduce the drain upon that tree to a certain extent, and then I want to put that tree in shape for future operations. Never plant a tree to-day without shaping it with reference to spraying. We mostly adopt for spraying Paris green and Bordeaux Mixture. So we want to plan in the setting of the trees and shaping the trees so they can be handily sprayed. I have learned at a cost of many thousands of dollars that it is foolish to leave great bushy tops on our trees. We want to train them so as to throw them open to the sunlight, and so they can be reached by the force pumps in order to be successful in reaching the insects and fungus. In spraying our trees we more and more get inside of them, and we want to throw it open so as to let in the sunlight and so that the Bordeaux mixture can have an opportunity to find all parts. You might just as well leave the tree back in the nursery as to attempt to start in and not have all of these facilities for this kind of work. Now, in planting your tree, keep it going in this manner continually. Keep your trees down. Heads down. Don't let them get out of reach. After a while, if the trees are kept in this manner, we shall be able more successfully to control many of the worst insects that annoy. This principle will apply to all trees that I might mention. Cherry trees will not stand so much pruning. They will be an exception. When you get your cherry tree shaped properly it seldom needs any pruning after that. But with most other trees a slight annual pruning of the wood is essential.

I want to speak now particularly of one or two insects. I can only touch upon this question very briefly, making a few suggestions for you to follow out by further study. I believe to-day we are losing more fruit, and that we are cut out of more of the product of our orchards, by the operation of the bud moth than any other one thing that I can name at the present time. I believe the bud moth is responsible for more failures of apple crops in Connecticut and in New York state, and in the East generally, than any other insect that can be

named at the present time. Our nurserymen know that they have to contend with it here. That insect destroys thousands of trees. It just destroys the natural growth of many trees, and they have to be rejected. But when we come to our orchards, here is where we suffer from the insect, and I believe, comparatively speaking, we suffer more from this insect than from most any other. It does its work early in the spring. As soon as the eggs are hatched these young larvae go right down into the bud. It eats into the bud. If it is not headed off before the buds are swelled sufficiently, it will begin at the end and it bores right down into the inside. Now, how many of you know of the presence of the bud moth in your orchards? I would like to see. I see a few that know what this bud moth is.

QUESTION. Is this the same insect that attacks grapevines?

MR. POWELL. Yes. There are but very few trees that are free from it; in fact, all fruit trees are subject to its attack. Early in the season you will see that a great many buds are open. There is where you are deceived. The buds will open and the blossoms will be formed, but they have been destroyed. The germ is injured, and while the trees are blooming we are confident of a good crop and wonder why it is afterwards that the orchard does not bear half a crop of fruit. I do believe to-day that while we are frightened at the San Jose scale we have no right to be. We are losing every year from this little moth a thousand times more than the scale has ever cost us. Now, let me ask you to watch this thing next spring, and when you discover any imperfections about the buds of your trees commence your spraying at once. I would prepare now. To-day, when you go home from this meeting. If you have not a force pump, I would order one right away. I would order my Paris green at once. I would have the materials right at home. I would have everything in readiness on the place in the spring, and as soon as the buds show evidence of life go right through the orchard and spray with the Bordeaux

mixture and Paris green. Now, if you have got the bud moth, which you all have to a greater or less extent, put your Bordeaux mixture right to work, and in spraying at that season of the year you destroy the germ of the scab, which is also responsible for great losses. It is imperative to spray at that time in order to control the moth, and you should begin from the beginning of the season and spray continually after that. Now, while that is being done, put Paris green in your mixture. I mean while you are spraying for diseases you can put Paris green in your mixture, and you can help to wipe out this insect, the bud moth.

Now, I have given you a pointer. Now, observe and study it up yourselves. Use your knowledge and your station here. Now, from this time on use all the information you can get and be ready next spring to head this little pest off.

Before I leave the apple question I want to speak of one more point upon which it seems to me our success is going to depend entirely, and that is the quality. I had sent to me some specimens of an apple that it seems to me is typical of everything fine. I believe the future is going to depend upon our furnishing a very much finer quality. We are going to meet with a tremendous competition from every part of the globe. Foreign fruits are coming in in enormous quantities this year, and if we want to hold up the life of our apples, and hold our own market with our native fruits, it is hard to do it while there is fruit coming in here of such fine quality as was never seen here before. We can never do this, we can never hold our own in our own market unless we hold up the quality of our apples. I believe that is imperative.

Now, here is a Sutton Beauty apple. Many people like the Baldwin apple. The Baldwin apple is handsome. It is beautiful to look at, but it is an inferior apple when you come right down to it. Unless you can grow on certain soil you get a very poor quality in it. It is universally liked, however, because it is so handsome. Now, here is an apple that is very

typical of the Baldwin apple. You see it is almost alike in color and size and shape, and in almost every way, but it is two hundred per cent. better. Yes, two hundred per cent. better. Now then, let us plant the Sutton Beauty apple, and plant no more Baldwins. Let us call upon our nurserymen to propagate the Sutton Beauty. I tell you if you put that apple before the people we will increase the consumption one thousand per cent. of that fruit. That will be the result. We can do it just as well as not. We can give the people that which they will wish they had more of, and then we have solved the question of the consumption of our fruits. So I want to speak emphatically in regard to the selection of varieties that we select those that are fine appearing and fine flavored. We have got that right here. It will withstand the winter climate better, and it has a foliage that makes it almost unnecessary to spray. This resists fungous attacks. I believe that here is an opportunity for us to grow a fruit with great profit if we will only choose fine characteristics such as this variety has. Now, that is a principle that I would carry through the whole of fruit culture. Plant for quality. When we do that we are doing the most to increase the consumption of fruit of anything we can possibly do.

QUESTION. How does that apple compare with the Baldwin for productiveness?

MR. POWELL. Equally.

QUESTION. How does it compare for keeping qualities?

MR. POWELL. Equally good. There is this peculiarity about it. I think you may have had Mr. Hadwen here some time. If not, you will be fortunate when you can, for he is a very delightful man and a very practical man. He has been giving special attention to the study of this apple, and he has found everywhere, where he saw it in Massachusetts, that it was meeting with the very highest success. This specimen came from Storrs Agricultural College. I am delighted to recognize it. That is one of the finest apples I ever saw.

And you have got a tremendous opportunity here with this fruit to compete with other apple-growing sections that do not have the same climate or soil. It will be a strong competitor of the Missouri Ben Davis. We can knock that out. All I want is to see the Missouri Ben Davis knocked out with the Sutton Beauty. We can knock it clear out of the market if we put them together.

QUESTION. Why hasn't this apple been grown more generally?

MR. POWELL. It is an old variety and was introduced in Massachusetts many years ago, but it has never been sufficiently well introduced to have got into the commercial lines to any extent. It has taken time for this apple to become known.

MR. HALE. It is a poor grower in the nursery.

MR. POWELL. Give me this Sutton Beauty. If the public once find out about it they will say, give us the Sutton Beauty and we will pay you for it. I would rather give 25 cents to get a tree that is fine, than buy a Baldwin for 10 or 12.

QUESTION. Are they like the Baldwin in the respect that they produce every other year?

MR. POWELL. You can get a crop every year. Now I want to say just a few words on pears. The pear is still a luxury to most people. It ought not to be. Coming through the Boston market this morning I found this elegant fruit of which I show you a sample, selling at \$6 a bushel. Why? Because it is a luxury. Common people cannot buy this fruit at all because it is \$6 a bushel. Now, that shows what a field there is for us for fine pear culture. We have not begun to enter into the development of fine pear culture in this country. My own state is growing pears, and western New York does certainly produce some superior samples of this fruit.

But I am sorry to say that the pear orchards of New York are in most instances in a condition of decline. During the

past ten years, out of an orchard of 2,000 trees, I have lost 700 beautiful trees. Seven hundred are gone by the persistent efforts of one little bit of an insect known as the pear *Psylla*, and that insect is working generally all through New England. It is the great enemy of pear culture and pear development to-day. Now the reason for this is that it is never discovered in time. That was my case. The last crop of pears which I sold from my place was 1,250 barrels, all of which were varied in quality by that cause. I will try and give you a description of it so you may discover it. Now the pear *Psylla* is an insect that is entirely different from anything like the caterpillar.

In the handling of insects we seldom understand the difference between species, and before we do learn about it they have done us immense damage. Now there are two classes of insects that are doing great damage. You want to keep in mind what they are so as to know how to treat them properly. If you will keep in mind just this fact, that there are two classes it ought to be of great assistance. One is the class that has biting jaws that eat foliage. Keep that in mind. One class has jaws that eat. Now there is an effective treatment for that class, and that is poison. Now this can be easily kept in mind. All insects that eat are controlled by poison. Hence, for caterpillars, worms, and insects of that sort Paris green or London purple, or any poison that they can eat will kill them.

Now the next is an entirely different class, and that really is the most dangerous we have to confront. That is the class of insects that do not eat, but which suck their life. They are dangerous in every sense of the term. The pear *Psylla* is of this class. There are hundreds of people that go to spraying with Paris green for this upon our trees. It doesn't affect them at all. Simply because it don't hit them. You have got to understand something about the insect in order to know how to treat it. The most effective way is to treat

them with kerosene emulsion or whale-oil soap, or any such oily substance. Such substances as those will destroy them because they breathe through openings in their bodies, and the closing up of those breathing-places just smothers them out of existence. Just watch and see whether the insect that is preying upon your trees is eating the foliage or whether it is found right at the base of the bud. Here is a class that sucks its life, and you must know how to distinguish between the two classes of insects as I have described them in order to know how to effectively treat them. The pear *Psylla* comes under this type. It runs its proboscis down in between the layers of the coverings of the bud and sucks its life out, and, upon being treated with kerosene emulsion or whale-oil soap it can be stopped, certainly to a large extent. If you go and examine in the crevices of the bark to-day you may be able to discover some of these little insects not more than a sixteenth of an inch in length. You will find them in the crevices and cracks hibernating through the winter. Now the first pleasant days of next April or May these insects come out and they begin to deposit their eggs any time just as soon as the warm days come, and you will find the eggs laid right along on the base of the fruit sprouts; little shiny yellowish colored eggs. As soon as your buds have appeared these eggs begin to hatch and these little bits of tiny things which you cannot see with the naked eye commence to work right into the axils of the stems of your fruit. And there they suck the sap right out of it. Then they exude from their bodies a sticky substance known as honey dew, which, as they grow older, runs down upon your pear branches and on the bodies of your trees. That pear *Psylla* is what is the matter. That is not the pear blight. It has no connection with the pear blight whatever. Now these little insects will grow, and in a short time the new brood will commence to lay eggs, and they will increase a hundredfold within a very short time. So you have to guard against a great increase of these insects

which are just ruining our orchards. Just about four weeks from the time the first brood appears there will be a second. And frequently there will be even the third brood that will come out. They hang on eternally.

Now, then, as for the treatment. I don't know as there is anyone here that has fought this thing more persistently than I have. I have had the reputation for growing some good pears, but I am afraid I have lost it now. I have not had any to put on the market for several years. You want to start in with whale-oil soap or kerosene emulsion just as soon as those eggs begin to hatch. Watch on the warm days and see whether this *Psylla* is hatching. Put the microscope upon the axils of the fruit sprouts to see if they are there. You will be surprised to find anywhere from three to five of them on a little single fruit sprout. Then give them a dose of whale oil-soap, in a dilution of one pound to ten gallons of water, or eight is better, or kerosene emulsion in the proportion of one part to twelve or fourteen. I very nearly gave orders to my men to start in and cut down two thousand trees clear to the ground. I had fought this pear *Psylla* until I became almost discouraged. But I hated to be beaten. So we went out in the spring from the very beginning and took one young orchard and went through it and drenched the trees thoroughly. We poured on whale-oil soap until it ran down in streams from those trees. I went up the next morning to make an examination, and, to my surprise, I counted on some fruit sprouts three dead ones and two living ones. I counted on one fruit sprout fourteen, seven of which were dead and seven living. And so we went right through in this way, and yet even with that extremely thorough work I had only succeeded in killing somewhere near one-half of them. Now that is the situation of this whole question. I cannot see to-day whether with the increase of that thing which has come upon us, whether it is going to be possible for us to control them or not. But I believe if this treatment is persisted in it

may be possible for us to grow pears of a high quality under this system, and it may be possible to control that insect. I certainly hope so. Now, this is not a very hopeful condition of things to give you, but after seven years of persistent fighting I must say I stand here to-day more discouraged in the face of the pear Psylla than anything I know of at the present time. It may be possible for a man who starts a young orchard to grow fruit as fine as this. If he does he has got a most luxurious fruit in his possession — a fruit that will always command high prices. The market of the future will reject common stuff.

QUESTION. They don't have this in California, do they?

MR. POWELL. They have not as yet had a visitation of it, but it is only a question of time when it will get there. They sent us the San Jose scale, and the pear Psylla will go back to pay them off for it in time. It will be an interchange of courtesies.

MR. HALE. You think the reason they come here is that they like the flavor of our fruit better?

MR. POWELL. Yes; they seem to thrive better here anyway, there is no doubt about it.

MR. GOLD. Has smoke been tried to attack this insect?

MR. POWELL. No, I don't think it has. I don't think that kind of treatment has ever been tried. It may be possible that that will prove an effectual means of coping with it. I want to say in this connection, by way of encouragement, that from some cause this Psylla has been perceptibly reduced. It may be due to the wet seasons, but that thing has been wonderfully reduced this past year. It has been reduced many fold compared to what it has been in the past seven years. It is a question whether it is the treatment or whether it is the wet season that has drowned out the generations as quick as they were born. It may be that has done it.

QUESTION. What do you think of transplanting trees in the fall as compared with spring setting?

Mr. POWELL. I think on soil that is not too heavy, that is well underdrained, or is naturally underdrained, the fall planting is very desirable. I should say with the exception of peaches, plant your trees in the fall. Plant them as early as you can get them, but in doing so protect your trees by mounding them up heavily. You may gain from four to five months' growth in that way. I am in favor of fall planting on all suitable land.

Mr. PLATT. You spoke about the general appearance of the trees in your orchard that had been treated with crimson clover. Was there any difference in the appearance between the looks of the trees in these two orchards that you spoke of?

Mr. POWELL. Oh, yes; the trees where this crimson clover treatment has been carried on for five years are brightened up a great deal in color. They are showing more strength. Notwithstanding the fact that the wet season has injured our foliage, yet these trees have gone right through the season and made growth and presented a fine appearance.

QUESTION. How old is that orchard?

Mr. POWELL. That orchard is now twenty-five years old.

QUESTION. Is that pear orchard now a bearing orchard?

Mr. POWELL. It should be. It would be if it were not for the pear *Psylla*.

QUESTION. In regard to the cultivation of your orchard, how late do you carry that process on?

Mr. POWELL. I would not delay pushing the cultivation of my trees and I would not carry it beyond the middle of July. I think the tillage prior to that time puts the soil in such condition that the moisture which is conserved will carry the crop through. And so I do not aim to cultivate any orchards much past the middle of July.

QUESTION. Doesn't the fruit require more moisture, and isn't it necessary that the tillage should be kept up for that reason? Wouldn't you increase the size of your fruit by encouraging the moisture after that?

Mr. POWELL. With a thorough system of tillage through the months of April, May, and June I think you have accomplished virtually all that is desirable in this direction. I would rather then let my cultivation cease and put on my clover and let that cover the soil, which it does gradually, and so carry my crop through under that process.

QUESTION. Going back to the bud moth, is it possible that you can find out whether those eggs are being laid by close observation, or is it necessary that you should use the glass in order to know whether you have got the pest?

Mr. POWELL. You cannot discover the egg laying until later in the spring. They hibernate, and then when the warm days come they come out and lay their eggs in the spring, and you will have to watch very closely for that. It is done before the buds are open. With good eyesight you might be able to discover it.

QUESTION. I would like to inquire if the speaker has had any experience with winter treatment against this insect. Against this pear *Psylla*.

Mr. POWELL. It was supposed at one time that the eggs might be laid upon the loose bark upon the trees, and it was supposed that by spring perhaps they could be killed. But it was discovered that they could be put right into sulphuric acid and still hatch all right. You cannot reach them effectively in the egg form. You have got to take them when the little thing comes out of the egg.

QUESTION. I would like to ask the gentleman a question in regard to the pruning of apples. I would like to ask whether it makes any difference in what part of the season you prune your apples?

Mr. POWELL. If I was to choose my time I would rather prune my trees near the season of growth. But I am satisfied that where it is necessary I would start right in on pleasant days now and begin and prune right through, when the wood is not frozen and apply to every wound a dressing of

the Bordeaux mixture. It doesn't affect your wood, and you prevent bacteria that are coming into the trees. I had an experience with pruning in July once. I had some young men who were studying horticulture, and they were anxious to get some practice in the art of pruning, and they became so interested in the practice of the art, that they said to me one day that they would like the privilege of pruning an orchard of three hundred trees. They took off their coats and they went at it, and they did a very fine piece of work, because they were educated intelligent young men. I never had finer work done in my life. They pruned the whole orchard, all that was necessary to be done, right in the month of July. They applied the Bordeaux mixture, and wherever that was applied there was a better healing over than where they simply applied wax, but in either case the healing process was delayed until the next season. We saw no healing over at all until the following season. It seemed to me as though it was quite possible that injury had been done, but it has healed over very finely indeed, and it is perfect wherever the Bordeaux mixture was applied. I would not recommend pruning at that season of the year, but I would say that commence in the autumn now and after pruning apply a dressing of Bordeaux mixture. I would prune right up to the spring growth.

QUESTION. Do you prune your pear trees the same as you do your apple trees?

MR. POWELL. I have just begun a system which is contrary to all rules. I am going right into my trees, and I am heading them down. I am just going right straight through and cutting off all branches that are away from where we can reach them. We are heading them right down, and I think we are going to get some good results from it. Although I do not want to say with positiveness because it is a matter I have not tried until now, but I am doing that and am willing to take the result.

QUESTION. Did you have an apple crop this year?

Mr. POWELL. No, sir. My apple crop, except upon some Sutton Beauty trees, was practically a failure. During the height of our blooming season, for thirty days, we had our streams raised three feet. That, of course, was very unusual to have through that period such a heavy rainfall. The result was that when we came out of that period we had nothing left. The pollen was absolutely washed out of our blossoms.

QUESTION. What is the work of the bud moth? How does it appear?

Mr. POWELL. You will find, if you look closely, the leaves tie together. As the larva grows it throws out a silken cord and draws up around the bud so that it will cause the leaf to roll right up, and there it lives and works inside. You will find these little threads drawn right together. You will find these leaves all over your trees. Sometimes it prevents the opening of the bud at all. It begins to operate right at the base of the bud, and it never opens.

QUESTION. Will you kindly explain to us how you manage to cultivate low-headed orchards?

Mr. POWELL. I do not head down, as many recommend, for the reason that when I set my first orchard we did not have the machinery we have now. I do recommend heading down trees. You can head your trees down quite low, and you can run right under the low-headed trees and cultivate the ground very well. My idea is to head my trees from four and a half to five feet from the ground. Your branches will almost come down to the ground even at that height, but I hold up pretty close to four and one half feet to five feet as the height for heading my trees.

QUESTION. Would you treat Rhode Island Greening that way?

Mr. POWELL. You must put that up to five feet anyway. You must prune it higher.

Mr. HALE. Mr. Powell wants a moment's rest, and while we have such a large audience here that is interested in fruit-

growing, I would like to announce on behalf of the State Pomological Society, that the annual meeting of the society of this year will be held on Wednesday and Thursday, the 7th and 8th of February, in this city. We have been wonderfully interested in the address of the gentleman this afternoon. It has been an address just bristling with live points of scientific value. I hope all of you who are interested in fruit-growing will make an effort to attend the Pomological Society.

Mr. POWELL. Now the question of the choice of varieties of apples has been referred to here by Mr. Hale. I think it has been stated that some choice kinds are difficult to grow in America. I have adopted the plan of growing the Tompkins County King, an apple which is so fine in its flavor and so beautiful in its color that it is very highly prized in the English market. It commands in the English market a very high price, whenever the fruit is shipped there in fine condition. Yet as a tree I would advise no one to plant it, because it is constitutionally defective and weak. After you have planted that variety and spent twelve or fifteen years of labor over it, the tree is gone. Before it begins to bear profitably the tree is virtually gone. Now how to get over that difficulty was a great question with me. I started in by planting the Northern Spy, which is one of the most vigorous growing trees that I know of. I discovered it in this way: Years ago, when going in and pruning my orchards all day long I found that I could tire myself out before noon on my Northern Spy trees. When I struck a Spy tree and started to prune that, that was business. You might just as well attempt to saw through a coil of steel as to saw off your Northern Spy branches where they had reached a size where it was necessary to use a saw. Now that set me to thinking about that tree. You could go through the Baldwin and Greening with a great deal less effort. You couldn't saw off one of the Spy limbs without working like a trooper. Taking that as a suggestion it occurred to me that the Spy would be valuable for top work for

other varieties not so heavy and so strong in their wood growth as the Spy. So for several years I have been working on this line.

I was speaking before the Missouri Horticultural Society on this subject two or three years ago and I made this statement there. Colonel Evans, who is one of the prominent growers in Missouri, said, "You are the only man in the United States that I have heard of who has found that out." He said he supposed he was the only man, and he said, "Since you have discovered it, I will tell you how I discovered it, since it is out. You know that fruit-growers don't keep secrets that are of value to each other. Anything that is of benefit to each other they give away. Anything that will be of help to others we publish instead of keeping it to ourselves." He said that in plowing among his orchard one mule would plow up anything there was until he came to the Northern Spy roots, and then he had hard work, and so found the root of the Northern Spy was very much stronger than the roots of other varieties. So you see by using the Spy in this line you can get a very strong and healthy top condition. So upon that principle I went to work with the King and Spitzenberg. I had no Sutton Beauty then. I had not known so much about the Sutton Beauty, so rather than run any risk I put the Sutton Beauty upon the Spy, and here is one grown upon a tree only set three years ago. That fruit came off a three-year graft, and the tree is ready to grow a great deal more of this kind of fruit.

QUESTION. Do you recommend regrafting old trees?

MR. POWELL. If they are not too aged I would regraft every one.

QUESTION. Some of mine are quite old, and I was interested to know whether I could do anything in the line you suggest with the tops?

MR. POWELL. Such trees as those are pretty difficult to regraft. If they are very old I wouldn't recommend it, but

I would rather start down with young trees. If you have got growths of five, six, or eight years standing which are producing undesirable varieties, you can change them over into something very desirable in this way. I do like this Spy stock very much for top work.

QUESTION. Do I understand you to say that the Sutton Beauty is not hardy?

MR. POWELL. I do not know. I think it is hardy.

MR. HOYT. I want to say just a word on this question. It is not all gold that glitters. Remember that. That may be a good apple. I believe it is. But for our farmers, taking a tree and putting it up on the hills as they do, without any great amount of cultivation or care, put out the Baldwin every time. You put out your apple trees for money. You put out your apple trees to make money from. The Baldwin will give you money. The Baldwin doesn't require so much cultivation, and doesn't require so much manure as that variety. That variety is all right if it is cultivated, as a farmer should cultivate an orchard, but not as most of our farmers do cultivate it. That is the point. We grow the Sutton Beauty, and have grown it for years, but the call is limited. Therefore, we do not cultivate as many as we do of other varieties, because we do not want to throw them away. While we have twenty-five or thirty thousand Baldwins, yet my friend says don't set them out. We have got perhaps fifteen hundred to two thousand Sutton Beauties. The Baldwin will go probably as soon as the Sutton Beauty, and if our excellent lecturer puts you all into the idea of getting Sutton Beauties we shall be able to supply perhaps a couple of thousand of them, but if the demand is like that for the Baldwin you will have to send all over the country to get them. You can get the Sutton Beauty, but in such a case perhaps you will get some trees that when they come to bear they may bear Baldwins.

THE CHAIRMAN. Our nurserymen wouldn't do that. (Laughter.)

Mr. HOYT. Men do it. There is money in the Baldwin, because it is a good grower, and it is known everywhere in this country.

Mr. HALE. I think there has rather been an impression left upon the audience that this was a tender tree. It is not so, Brother Hoyt. I have got to tell you that in my opinion you are mistaken in that. If you will go up into the northern part of Windham County, or go into Worcester County, Massachusetts, where this apple originated, more than fifty years ago, you can find all the Sutton Beauties you want. And the farmers will tell you that it is hardier and grows fully as vigorously, and bears fully as well as the Baldwin.

Mr. HOYT. Don't understand that I said it was a tender tree. I didn't say so. I said it was not a strong grower, and it is not a strong grower. If it is such a wonderful variety, what is the reason it has not come forward like the Baldwin? The Baldwin apple has been a standard apple these sixty years. What is the reason we haven't found out the good qualities of the Sutton Beauty? It strikes me that it is somewhat strange that it has not obtained a stronger hold. With all these good qualities which are claimed for it it ought to have become popular long ago.

Convention adjourned to meet at 7.30 P. M.

EVENING SESSION.

Thursday, December 15, 1898.

Convention called to order by Secretary Gold at 7.30 P. M.

Mr. GOLD. Before the regular exercises of the evening commence, we have some questions in our question-box which we will dispose of. I will read them.

"Why do our farmers and market gardeners raise the pink tomato almost to the exclusion of the delicious crimson varieties?" Some of you who are familiar with the market, perhaps, can tell us.

Mr. HINMAN. Because they are solid and taste better.

Mr. Gold reads. "Why do they send them to market before they are half ripe?" I suppose it is because they keep better.

Mr. HINMAN. Because they don't taste quite so good when they get a little bit past their prime.

Mr. GOLD. Of course they can be handled better in that half-ripe condition than after they are fully ripe. A fully ripe tomato won't bear very much handling.

"Tomatoes picked just when they begin to change color, and ripened in the light are always sour and watery. I have not seen one basket of the red ripe tomatoes in the market this year."

Mr. Gold reads. "What shall we do with our surplus hay? There is very little demand for it in the market?" No one can doubt the statement that is made there.

Mr. STADTMUELLER. That is a very good question. In all probability a large proportion of the agriculturists and farmers of the State have had that question in mind many times. The position I take upon that question is this: There is no method at the present time that offers as large returns for our hay as is obtained by converting it into dairy products. As long as that condition obtains, dairying is the natural solution of that question.

Mr. POWELL. I would say to the gentlemen that there is another very valuable channel through which to dispose of our surplus hay, and that is in horses. Raise finer horse stock. Europe to-day is calling for American horses as she never has done before. There is no place in the world where horses can be raised so cheaply as in our own country. I would add to the gentleman's solution of that question the suggestion that you convert it into valuable horse stock.

A MEMBER. I have frequently left over quite an amount of hay. I presume I have got forty tons left over from last year. I bought about fifty head of young cattle. That is where I am putting my surplus hay. I have got an idea that I can double my money in another year.

Mr. GOLD. I think that is pretty well answered. Here is dairying and raising young cattle, and raising horses. If those three lines are carried out the surplus hay question will disappear.

Mr. HOYT. I want to ask Brother Powell how small a price can hay be sold at to make it profitable to feed for raising horses?

Mr. POWELL. I do not think we can afford to let hay go for a dollar less than ten or twelve dollars a ton. I think it can be converted for that purpose at a more profitable rate than to sell it for a less price. I have demonstrated it.

Mr. HOYT. I am simply looking for the best way to make the most out of it.

A MEMBER. In regard to raising hay for market and the average price of hay in this State, especially in the manufacturing portion; the average price is \$15 per ton. Taking a series of ten years together the average price has been about that. I never would sell if it was not for the trouble of stacking it for less than \$14 a ton. I am selling this year for \$12. But as long as there is room enough outdoors to stack it, there is no use for us farmers to waste our hay. There is always a greater demand for it than the supply, except perhaps the demand in the last year or two has fallen off. There is nothing like the amount of hay raised and sold in the State that is consumed within it. It is brought in by carloads in all our villages. I know it is in the shore villages and those on the Connecticut river, and it is also into the cities. Three tons are brought in for sale where there is one ton raised locally for sale. I do not believe as long as we have got barn room or room enough to stack it in allowing our hay to go to waste, for there is always a good market for a fair quality of hay.

Mr. Gold reads. "How can a farmer keep grapes so as to have them in the winter?" I will call on Mr. Powell.

Mr. POWELL. You have got to grow varieties that are thick skinned for winter holding. You cannot keep tender

varieties. After the proper variety is selected then the question is how to keep them. In order to keep grapes well into the winter, your grapes should get fairly well ripened upon the vines before they are picked, and then stored away in boxes holding about twenty-five pounds. Pack them in layers, putting in, for instance, first a layer of cotton with paper over it, and a layer of grape leaves next the fruit. Then a layer of grape leaves over the fruit. Then paper, and then a layer of cotton, and so put in three layers of grapes into the box. In that manner you will keep your grapes in good condition free from mould, and you can keep them up to and beyond the holidays, and even through the entire month of January, but you have got to choose late ripening varieties with good thick skins.

MR. GOLD. Mr. Powell has answered the next question, which is: "What variety or varieties are the best for late keepers?"

MR. HINMAN. I want to say that among the best grapes I ever ate in the world are the Isabella. They are not so fashionable now, but the time was on my place when the Isabella would ripen and keep in splendid condition well along into the winter. I have eaten them in March just packed in cotton. Just laid down in cotton. I have eaten them in March, and had them just as nice as any I ever tasted in the world. I do not know of any better grape for such a purpose than the old Isabella. I only regret that we don't seem to be able to ripen it to-day. I don't know why.

MR. GOLD. "What is the best fertilizer for the strawberry crop, and when should it be applied?" Brother Hale?

MR. HALE. I don't know, but it depends upon the soil and upon the strawberry plant. You want to put in a good fertilizer that is rich in potash. That is what will make strawberries grow.

MR. GOLD reads. "Do other sections of the United States have as much to contend with in peach-growing as we do here in Connecticut?"

Mr. HALE. Yes, sir. At the meeting of the Ohio Horticultural Society last week it was stated by a gentleman who had been traveling over the State that their great orchards of hundreds and thousands of acres were doomed. The crop of '99 would not be great. Ninety per cent. of their trees, they say, are infected with the yellows, and the curling leaf is ruining the orchards in western New York. The brown rot and other things are attacking them in Missouri. It is the same everywhere. The people in other sections have quite a number of things the same as we have to contend with, and the difficulties are no greater here in Connecticut than elsewhere.

Mr. GOLD. The time has now come for the regular exercises of the evening. I expected to have Mr. Frank M. Chapman here from the American Museum of Natural History of New York, to give an illustrated lecture on "The Value of the Birds to the Commonwealth," but he has been unable to come, from illness, and Mrs. Newell will read a lecture in his place.

This lecture has been prepared by the Audubon Society of Connecticut, illustrated by lantern slides, and in this emergency has been kindly loaned for the occasion. This is the first time this lecture has been presented to the public, and as it is designed for future use, it is withheld from publication. No excuse is required for any possible shortcoming or irregularity in the exhibit, as it was only yesterday morning that I received notice of the inability of Mr. Chapman to be present, from sudden illness.

The CHAIRMAN. Now the audience will please give their attention to Mrs. G. H. Newell, who will read a paper entitled "Facts about Birds that Concern the Farmer."

The CHAIRMAN. I am sure you will all wish to express your thanks to Mrs. Newell for reading this beautiful lecture, especially when we know that she was called upon very suddenly to do so. I think we owe her a vote of thanks, and I will ask you to express it by rising.

A unanimous vote of thanks extended to Mrs. Newell.

Mr. POWELL. I want to say a word upon this very interesting and valuable paper. I think no one could have listened to this paper without having been impressed with the value and importance of the relations which the Audubon Society holds towards the agricultural and horticultural interests of this State. I think that fact has been very clearly exemplified here this evening. And I am very glad that there is an organization engaged in work of this character. It appeals to us all for the heartiest co-operation in furthering its objects. We have been discussing here to-day the difficulties of our fruit-growing and among the greatest of these difficulties that we have to contend with are the hordes of insects that are continually contesting the ground with us. There is no doubt but that the loss of our birds accounts for so many of these pests and for the wonderful increase in the insect world.

Now a suggestion as to how we can co-operate with the Audubon Society. I think each one of us, as fruit-growers, can plant trees especially for them. Especially for the birds. When we lay out plans for an orchard, let us surround that orchard with trees in which the birds can nest. I make that a practice. I make it a practice to plant especially evergreen trees, and for two purposes, one to protect the orchard from the force of our sweeping winds over the fields, and, secondly, to induce the birds to come and nest and live by the side of my fruit-bearing trees. In that way we can co-operate readily and do great good in extending the objects of the Audubon Society.

Another way will be to incorporate instruction in our public schools along this same line. If we teach the boys and girls to take an interest in things about bird life we shall change this tendency which our boys especially have to kill and destroy every bird that they come across. We want to teach them better in our public schools. I think we can teach them the important lesson of trying to aid in the preservation

of this most valuable kind of life, the life of our birds. I want to say that we have co-operation in our State in the extension of this principle. We have included bird life as a subject. Then, again, teachers can be interested and shown how to study bird life right from the field. We have taken that up in our institutes. That is one of the lines which we are working on in New York State.

Now I want to say just a word as to the practical value of preserving bird life to farmers. I had a curious illustration this summer of how some crows assisted me in preserving a valuable strawberry plantation. We had some nice beds, and, owing to the weather, I suppose, there was a very great development of grubs. I thought I had the land clear of them, but, unfortunately, the wet season brought them to the surface, and they commenced to make great havoc among my strawberry plants. But we discovered that every morning there was a crowd of crows that gathered over the beds. Every morning my man would say, "The crows are down there in the field in quite considerable numbers," and they could be seen working up and down the rows, and we soon discovered that they were there working those grubs out of the ground. Every morning the crop would be visited by the crows, and I have no doubt they saved me from having thousands of plants destroyed by the grub. Orders were given to under no circumstances allow these crows to be disturbed. The crow has not been very well thought of, but this example shows that there is value in cultivating the acquaintance of the crow and letting him get close to you.

Now, in regard to the wren. That is one of our birds that is fast disappearing. The wren has so absolutely gone from some of our homes that I presume there are children who could not describe it. One pair of wrens is said to be able to clear half an acre of cabbages of the cabbage worm when it exists. The wren is a wonderfully important bird in this respect, and deserves our protection. And yet that beautiful

bird is fast disappearing. The Audubon Society is entitled to our heartiest co-operation as horticulturists, and I want to say for one that I heartily appreciate the admirable lesson which has been given to us to-night.

Mr. HINMAN. Mr. Chairman, I do not want to detain this meeting, but I want to say that at my home I tried to cultivate a few flowers, and among the few I grow are roses. I have one climbing bush that bore some beautiful roses last spring, and when my friends came to see me they said, "What do you put on to keep your roses? You do not have any bugs." I don't put anything on, I told them. "Well, what is the reason there are none on any of these bushes?" I said, "You see that little nest up there?" Right on the piazza was a climbing rose bush running up, and right within a short distance of where I sat was the nest of a little bird. It was the yellow bird. When the female had finished her nest and laid the eggs she would get off once in a while and go and pick a bug or two, and then her mate would work among the bushes. And that pair of yellow birds kept that bush entirely clean of bugs. I never put one single bit of tobacco on the bush, as I usually do. Those two little birds, the male and the female, of ordinary yellow birds, nested there almost right within touch, and had their nest where I could see the eggs, and see the little ones, and there wasn't a bug on that bush the whole spring. There was an example of what two little birds could do.

A MEMBER. What has become of the barn swallow? I mean the swallow that used to come and build their nests up under the eaves of the barn. I have not seen any for a long time.

Mr. GOLD. I suppose the barns are built without loopholes for them to get in. The barns are better constructed and they cannot get in so well.

A MEMBER. I thought when the gentleman spoke of barn swallows, he referred to the eave swallow. I have under-

stood that these eave swallows were the same as the cliff swallows of the Rocky Mountains and the localities west of the Missouri River. Fifty years ago I used to read of them, and they gradually spread this way, and perhaps thirty or forty years ago they came into this part of the country. It may be thirty years ago that I saw the first ones that came into our locality. I have seen fifty of those interesting birds under the eaves of my barn, but for the last two or three years I have not seen one. The regular barn swallow has remained there to some extent, but they are not as numerous as they were a few years ago.

Mr. HOYT. Mr. Chairman, it is known to us all who can remember back fifty years that there is a great scarcity of birds now compared to what there was then. I can readily remember the martins and the blackbirds that used to follow the plow in our fields and pick up the worms. And farmers used to build cages on the gables of the barn, and martins would come there every spring and build their nests and hatch their broods. Our barns used to be full of swallows. You could count fifty or a hundred flying around at one time. Now they cannot have disappeared from being shot, and there does not seem to be any reason to account for their disappearance, but there has been a gradual disappearing of our birds in some way. If there is any way that they can be encouraged to stay, I think the farmers should be instructed how it may be done. There is one thing that the farmers can do, and that is to prohibit any person going on to their property with a shotgun. The law will protect the farmers in protecting the birds on their farms. We should put up notices forbidding shooting upon our farms. We have on our farm notices posted up all around. I think I put up a year ago at least fifty over our farm, reading "No hunting permitted on this farm," or something like that. If a person should come upon our farm with a gun I would go for him as quick as I would a burglar at night. I won't permit the slaughter of birds of any kind

if I can help it. It is a cruel and wicked piece of business to shoot these little birds who are perfectly harmless and do worlds of good. Our good Creator has amply provided for the human family without its being necessary for man to kill these innocent little quail and other birds like the robin and the meadow lark. If they cannot get along I think they had better give up eating meat and raise more fruit. Our fruits are being destroyed by insects, and the birds have been destroyed by those who want to eat fruit, for the sake of the sport. They take a gun and murder three or four of these innocent birds and call it sport. They take a gun and a dog and tramp around the lots day after day. I think men should be better employed. If there is anything that is disgusting to me it is to see a great man following three or four dogs around trying to shoot a little bird. I would recommend the putting up of notices, and if that is not enough I hope that this society can go before the Legislature and get a law passed whereby the birds can be protected. It behooves us to stand by this society and help them to pass any law they ask for.

Mr. HINMAN. I desire to present a resolution that may seem somewhat familiar to those who have attended conventions of this kind heretofore, but I trust that it will be unanimously passed.

“Resolved, That we, as farmers of Connecticut, assembled in our annual convention for the mutual benefit of ourselves and those whom we supply with the necessaries of life desire to thank the press for the aid that they have given to the dissemination of the knowledge developed by our discussions. We also thank the railroad companies for courtesies extended, and the hotels in the city of Hartford for so reducing their rates as to enable us at a minimum expense to remain in the city during the sessions of this convention. We especially desire to thank those who have so ably added to the pleasure of our meeting by furnishing music.” I trust that there will be no dissenting voice on the passage of this resolution. Any

amendment will be gladly accepted. I should be glad of any amendment, but I move its passage.

Chairman SEELEY. You hear this motion that is before the house. What is your pleasure with regard to it.

Motion seconded and unanimously passed.

Motion to adjourn *sine die* made, seconded, and passed.

NOTICE.

TREES.

I am very desirous to make a list with description and cuts of remarkable trees in Connecticut, forest or fruit trees, and I solicit from all parts of the State notices of trees remarkable for size or productiveness or quality of fruit or nuts, or of historic or memorial trees, in country or city. Negatives are better than photos to make plates for illustration.

Please send in your notes to make the list as complete as possible.

AGRICULTURAL REPORTS.

The Connecticut State Agricultural Society published reports in 1854, 1855, 1856, 1857, 1858, 1859, six years.

The State Board of Agriculture published its first report in 1866, and has continued annually since, except 1870, making this issue the 32d.

From 1879 to 1896, inclusive, the reports of the Connecticut Experiment Station and of the Storrs Experiment Station are bound with the reports of the Board. In accordance with the action of the last General Assembly these Station reports are not bound with the report of the Board of Agriculture, as heretofore, and those desiring these Station reports can get them as long as the limited supply lasts on application at the Stations.

I have on hand all the issues from 1879 to 1898, that I can supply to applicants, but for previous years I am dependent upon friends who may have them to spare, so that I may be able to complete sets, which are in great demand for the libraries of experiment stations and colleges, also for public libraries.

I want also all the reports of the State Agricultural Society. Any person who has any of these reports to spare will confer a great favor on agriculture by sending them to me by express or by mail, and in the latter case I will return postage.

Town clerks are particularly requested to regard this notice, and I will pay any expense of packing.

Address T. S. GOLD, *Secretary*,
West Cornwall, Conn.

REPORT OF TREASURER.

CHAS. A. THOMPSON, Treasurer, *in account with*

CONN. BOARD OF AGRICULTURE.

		DR.	
Dec. 21, 1897,	Received from Est. of F. M. Bartholomew,	\$226.50	
Jan. 14, 1898,	By State appropriation,	8,500.00	
			\$3,726.50
		CR.	
1898.			
Jan. 14.	Dr. Geo. T. Fairchild,	\$30.30	
"	Prof. L. H. Bailey,	56.52	
"	Dr. E. H. Jenkins,	27.50	
"	J. H. Hale,	27.00	
"	A. B. Peebles,	17.80	
"	W. H. Hammond,	82.95	
"	The Hooker House,	210.60	
"	Prof. I. P. Roberts,	49.86	
"	Annie B. Scoville,	28.21	
"	Prof. W. H. Brewer,	27.50	
"	Edwin Hoyt,	29.50	
"	N. S. Platt,	3.33	
"	A. C. Andrews,	12.00	
"	John Gould,	50.00	
"	E. G. Seeley,	19.22	
"	Seaman Mead,	24.55	
"	C. A. Thompson,	13.67	
"	E. J. Miner,	18.21	
"	Edmund Halladay,	29.06	
"	Frederic Doolittle,	14.98	
"	M. F. Latham,	29.50	
"	Est. of F. M. Bartholomew,	27.70	
Jan. 15.	The Case, Lockwood & Brainard Co.,	367.53	
"	T. S. Gold,	857.25	
April 15.	Dr. N. S. Mayo, Institutes,	4.81	
"	F. H. Stadtmueller, "	1.10	
"	Dr. W. C. Sturgis, "	5.10	
"	Dr. E. H. Jenkins, "	5.20	
"	W. E. Britton, "	1.90	
"	E. C. Birge, "	14.64	
"	A. G. Gulley, "	7.10	
"	N. H. Sherwood, "	5.60	
"	A. B. Peebles, "	16.20	
"	Miss Maud Knapp, "	3.95	
"	Prof. C. S. Phelps and wife, Institutes,	31.82	
"	Pelton & King,	20.00	
May 9.	Henry A. Ballou, Institutes,	2.47	
" 16.	L. P. Chamberlain, "	4.85	
1898.			
June 30.	N. S. Platt,	4.46	
"	E. J. Miner,	2.10	
"	G. G. McLean,	2.40	
"	Seaman Mead,	7.85	

June 30.	C. A. Thompson,	81.64	
"	T. S. Gold,	745.04	
"	E. Halladay,	1.50	
"	The Case, Lockwood & Brainard Co.,	103.60	
"	To balance, cash in Treas.,	704.48	
		<u>\$3,726.50</u>	<u>\$3,726.50</u>

This is to certify that the undersigned auditors of the State Board of Agriculture have examined the above account of the treasurer, and the accompanying vouchers, and find them correct.

Hartford, July 1, 1898.

FREDERIC DOOLITTLE, }
 SEAMAN MEAD, } *Auditors.*
 GEO. G. McLEAN, }

OFFICIAL LIST OF AGRICULTURAL SOCIETIES IN CONNECTICUT, 1898.

NAME OF SOCIETY.	PRESIDENT.	SECRETARY.	TREASURER.
Connecticut State.*	Geo. A. Hopson, East Wallingford.	B. W. Collins, Meriden.	Eugene A. Hall.
New Haven County.*	D. N. Clarke, Woodbridge.	Theo. W. Yerrington, Norwich.	Frank S. Platt.
New London County.	James A. Bill, Bill Hill.	L. B. Stetson, Brooklyn.	Chas. W. Hill.
Windham County.	Chas. W. Grosvenor, Pomfret.	D. C. Kilbourn, Litchfield.	P. B. Sibley.
Litchfield County.*	Harry Sedgewick, Cornfall Hollow.	Frank L. Wilcox, Berlin.	.....
Berlin.	Chas. M. Jarvis, Berlin.	John P. Callahan, Branford.	Francis Deming.
Bristol Fair Corporation.*	Edwin Doolittle, Branford.	B. A. Peck, Bristol.	W. R. Foote.
Cedar Valley.*	Ard Welton, Plymouth.	J. S. Kirkham, Newington.	B. A. Peck.
Cheshire.*	Levi S. Wells, New Britain.	Jared A. Smith, Chester.	E. F. Blake.
Clinton.*	Fred. S. Smith, Chester.	Clifford H. Everts, Clinton.	J. E. Smith.
East Granby.*	Edwin H. Wright, Clinton.	Wilbur H. Gay, East Granby.	Geo. H. Brooks.
East Granby.*	C. H. Hanchett, East Granby.	G. M. Rundle, Danbury.	Clinton Phelps.
Danbury.	Samuel H. Rundle, Danbury.	E. A. Hough, Collinsville.	J. W. Bacon.
Farmington Valley.	Oliver F. Perry, Collinsville.	Chas. Coffey, Granby.	B. F. Case.
Granby.	Geo. O. Beach, Granby.	A. H. Phelps, Guilford.	L. C. Spring.
Guilford.	Lewis C. Wilcox, Guilford.	Albert W. Buell, Harwinton.	E. R. Davis.
Harwinton.	Thomas Q. Hogan, Harwinton.	N. H. Everts, Killingworth.	Patrick Hogan, Jr.
Killingworth.*	D. K. Stevens, Killingworth.	Edward N. Willard, Madison.	A. B. Stevens.
Madison.*	S. A. Scranton, Madison.	Geo. W. Fairchild, Meriden.	E. N. Willard.
Meriden.*	Benj. W. Collins, Meriden.	J. H. Cochrane, New Milford.	E. A. Hall.
New Milford.	Andrew J. McMahon, New Milford.	P. A. McCarthy, Newtown.	Edwin J. Emmons.
Newtown.	Theron E. Platt, Newtown.	Wm. W. Hughes.	Henry G. Curtise.
Oxford.*	W. B. McEwen, Oxford.	Wm. D. Bugbee, Putnam.	.....
Putnam Park Association.	J. B. Tatem, Putnam.	Byron D. Bugbee, Putnam.	A. C. Stetson.
Rockville Fair Association.	Walter E. Payne, Rockville.	Ed. F. Badmington, Rockville.	Francis N. Randall.
Simsbury.	Edmund A. Hoskins, Simsbury.	Geo. C. Eno, Simsbury.	Geo. C. Eno.
Southington.	Geo. L. Messenger, Southington.	Wm. H. Cummings, Southington.	W. H. Cummings.
Stafford Springs.	E. C. Dennis, Stafford Springs.	C. F. Beckwith, Stafford Springs.	H. S. Abel.
Stafford.	Waldo S. Knox, Stafford.	A. N. Graves, Suffield.	J. O. Haskins.
Union (Monroe, etc.).	Warren S. Plumb, Nichols.	S. T. Palmer, Shelton.	D. S. Clarke.
Union (Somers, etc.).	Olin S. Olmsted, Melrose.	Milo Hamilton, Ellington.	C. A. Thompson.
Wallingford.*	M. E. Cook, Wallingford.	D. W. Ives, Wallingford.	J. P. Stevenson.
Williamatic Fair Association.	William P. Stevens, Williamatic.	Fred. A. Sanderson, Williamatic.	Frank Larabee.
Windsor.*	H. H. Elisworth, Windsor.	E. S. Hough, Poquonock.	E. F. Thrall.
Winsted.*	Elizur B. Parsons, Winsted.	Edward M. Platt, Winsted.	E. M. Platt.
Wolcott.*	H. B. Carter, Wolcott.	E. M. Upson, Wolcott.	E. M. Upson.
Woodstock.	J. W. Dike, Thompson.	H. W. Hibbard, Woodstock.	A. E. Brunn.

† No returns.

* No fair.

RETURNS OF AGRICULTURAL SOCIETIES, 1898.—FINANCES—RECEIPTS.

SOCIETIES.	Cash on Hand.	Single Admission Tickets.	Membership or Season Tickets.	Grand Stand.	Donations and Unclaimed Premiums.	Entrance Fees.	Other Entrance Fees.	Rent of Grounds.	State Appropriation, 1897.	Other Sources.	TOTALS.	State Appropriation, 1898.
New London County.....	\$775.23	\$2,450.40	\$70.00	\$396.00	.....	\$110.40	\$73.00	\$616.00	\$312.94	\$71.00	\$4,315.57	\$316.46
Windham County.....	.35	1,158.93	.....	177.60	.....	200.00	116.30	890.75	272.49	104.65	2,361.27	318.19
Berlin.....	110.53	300.25	125.00	35.75	\$240.00	.....	.....	20.50	114.96	16.45	1,074.83	139.90
Branford.....	132.18	366.09	.....	30.15	.....	80.00	.....	.....	102.40	52.00	860.88	104.95
Chester.....	2.52	43.80	15.00	.....	.....	1,740.40	631.45	4.00	1,006.04	69.13	230.85	102.81
Danbury.....	4,968.71	12,504.39	.....	2,454.25	.....	420.00	28.00	5,446.70	1,006.04	\$9,802.95	88,727.89	1,004.35
Farmingdale Valley.....	735.96	1,039.80	.....	149.60	.....	446.53	2.70	298.75	171.44	200.00	3,045.55	181.87
Granby.....	170.54	571.08	60.00	149.42	150.00	446.53	3.00	112.40	106.00	43.93	1,603.18	110.74
Guilford.....	.....	149.42	.....	.....	45.00	.....	.....	10.00	153.03	.....	443.80	150.38
Harwinton.....	18.96	.....	1.00	.....	.....	.....	13.95	331.00	129.17	.....	494.08	123.96
New Milford.....	1,040.15	971.75	.....	190.05	.....	432.50	37.75	267.51	155.25	\$2,023.79	5,127.75	165.65
Newtown.....	446.87	1,517.13	.....	482.25	100.00	407.00	7.50	312.10	175.61	546.87	4,155.33	204.54
Putnam Park Ass'n.....	.....	2,314.96	300.00	606.00	.....	767.50	192.75	417.00	.....	\$15,821.95	20,320.16	383.00
Rockville Fair Ass'n.....	.....	1,825.65	247.80	376.00	.....	937.50	130.95	558.50	.....	\$3,131.25	7,207.65	197.49
Simsbury.....	144.57	740.25	.....	876.00	36.50	857.00	.....	103.50	130.23	46.35	1,546.39	138.48
Southington.....	.....	828.97	63.00	102.05	.....	144.50	36.60	205.20	.....	108.05	1,488.97	205.03
Stafford Springs.....	3,378.48	2,945.95	228.00	778.43	17.20	700.00	231.00	759.75	407.93	173.48	9,650.22	464.66
Suffield.....	22.65	763.03	.....	76.03	.....	179.00	.....	60.10	117.43	181.87	1,006.11	193.76
Union (Monroe, etc.).....	12.49	711.05	183.00	52.35	16.00	179.00	11.00	63.50	172.91	152.50	1,006.80	190.36
Union (Somers, etc.).....	1,258.00	1,820.98	7.00	389.50	43.75	630.00	.....	75.00	125.86	141.22	3,650.88	128.72
Williamantic Fair Ass'n.....	339.96	462.95	47.00	389.50	21.50	630.00	24.00	385.00	109.77	205.35	3,966.06	132.81
Willimantic Fair Ass'n.....	966.01	783.68	76.00	117.95	.....	61.00	10.50	86.50	164.58	97.37	1,361.91	189.90
Woodstock.....	36.41	276.24	210.00	117.95	3.75	61.00	68.35	284.28	229.94	101.75	1,786.36	227.64
Conn. Hort. Soc.....	42.14	.....	.....	.....	.....	.....	.....	.....	151.16	60.00	766.13	141.59
Conn. Dairy Ass'n.....	142.13	.....	188.00	.....	.....	.....	.....	.....	1,151.16	.....	1,169.94	.....
Conn. Pom. Soc.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	280.13	1,102.03

* Insurance, \$9,500. + Borrowed money on mortgage, \$2,000. † Capital stock paid in, \$9,648; borrowed for buildings, \$6,000. ‡ Subscriptions to stock, \$3,010.

RETURNS OF AGRICULTURAL SOCIETIES, 1898 — FINANCES, CONTINUED.

SOCIETIES.	Expenses of Fair.	Premiums for Speed.	Premiums for Amusement.	Other Premiums and Gratuities.	Permanent Improvements.	Other Expenses.	Cash on hand.	Total.	Indebtedness of Society.	Real Estate.	Personal Estate.	No. of Stockholders—	Capital Stock.	Admission Tickets.	Season Tickets.	Grand Stand.
New London Co.,	\$4,416.32	\$770.00	\$300.00	\$1,004.05	\$146.30	\$1,159.96	\$6.94	\$4,515.57	\$5,000.00	\$10,000.00	\$300.00	151		\$6.35	\$1.00	\$6.25
Winham County,	538.30	530.00	235.00	1,011.25	88.89	62.50		4,522.94	5,000.00	5,000.00		710				
Berlin,	429.64	6.80		266.25			105.89	1,074.83	500.00	500.00		128				
Brantford,	287.22	200.00	50.00	159.05		50.00	150.51	946.88				60				
Chester,	71.57		10.75	111.76		10.00	33.78	266.85								
Danbury,	9,670.85	2,400.00	1,197.05	4,262.37	*18,038.41		8,169.21	38,727.89	30,000.00	30,000.00	3,000.00	301	\$12,000			
Farmington Valley	479.79	780.00	100.00	441.15		227.12	1,016.49	9,042.55	9,203.07	9,203.07	40.50	79	5,000			
Granby,	231.80	897.75	45.00	144.90		147.55	7.50	1,774.00	450.00	2,500.00	500.00	86	3,000			
Gulford,				300.05				868.97								
Harwinton,	202.94			200.10				404.68			250.00	113				
New Milford,	784.77	718.70		374.25		13,000.00	300.08	5,127.75	2,000.00							
Newtown,	653.60	998.00	480.00	536.60	1,295.85		96.50	4,155.33	1,100.00	16,478.45	7,000.00	117	5,000			
Putnam Park Ass'n	269.55	480.00	510.50	1,281.96	\$16,176.45	508.66	203.04	20,280.16	6,000.00			143	**10,000			
R'ville Fair Ass'n	475.06	1,050.00	811.45	507.20	\$87.17		992.13	7,307.65	1,000.00	4,000.00		106	††10,000			
Slisbury,	300.52	1,795.88		219.00	224.33	16.50	15.44	1,548.39								
Southington,	136.88	772.60	95.00	538.15		249.70	27.24	1,468.97		6,000.00	50.00	11	2,600			
Stafford Springs,	1,320.18	885.00	950.00	1,632.00	3,300.00		1,067.04	9,950.22	1,090.00	10,500.00	850.00	106	\$85,000			
Stimfield,	129.34	1,400.00		199.28	54.00	59.24	164.15	1,606.11	1,606.11	4,750.00	50.00	831	8,255			
Union (Monr'e etc.)	573.95	1,880.00		477.00			176.86	1,606.80	1,250.00	1,300.00		133				
Union (Som'r's etc.)			46.50	290.00		139.80	176.86	1,650.83								
W'm't'c Fair Ass'n	964.20		688.00	158.50	421.60	362.50	373.96	3,998.06			100.00	505				
Woodstock,	163.78	1,155.00		475.50		7.50	1,205.13	1,831.91	1,000.00	8,000.00		168				
Conn. Hort. Soc.,	638.12	153.45		38.53		325.00	52.31	776.18	1,000.00		1,475.00					
Conn. Dairy Ass'n,	428.83	170.00		373.75	30.00		38.25	766.18								
Conn. Pom. Soc.,				108.50			75.15					191				

*Paid on mortgage \$700. †New buildings and fixtures. ‡Paid note \$273. §Grounds bought April 1, '98. \$Buildings and tracks \$14,478.45. **Paid in \$9,043.

††Paid in \$5,110. ‡‡Paid in \$2,000.

ANALYSIS OF PREMIUMS AND GRATUITIES PAID.—FARM STOCK.

SOCIETIES.	Bulls.	Milch Cows.	Heifers.	Calves.	Working Oxen.	Steers.	Rat Cattle	Draft Oxen.	Horses, except Speed.	Horses, Speed.	Sheep.	Swine.	Poultry.	All other Stock.	Total.
New London County.....	\$60.00	\$233.50	\$22.00	\$16.25	\$40.00	\$16.75	\$15.00	\$17.00	\$157.00	\$270.00	\$304.00	\$14.00	\$37.50	.....	\$1,744.00
Windham County.....	71.00	93.00	93.00	4.00	40.00	46.00	6.00	\$86.00	156.00	520.00	24.00	21.00	41.75	.....	1,146.75
Berlin.....	6.00	26.00	4.25	4.00	4.00	1.00	1.00	.....	25.00	.....	4.00	7.00	19.00	\$6.25	1,065.50
Branford.....	1.00	9.00	.....	1.00	3.00	2.00	2.00	10.00	14.50	200.00	.....	.....	17.00	1.00	269.50
Chester.....	1.00	2.50	.....	1.00	1.50	.....	.....	.....	6.25	.....	.....	4.00	2.00	2.00	\$1.25
Danbury.....	190.00	191.00	136.50	42.00	89.00	46.00	9.00	32.00	265.00	2,400.00	54.00	.....	292.00	1,010.00	4,700.50
Farmington Valley.....	24.00	45.00	14.00	13.00	21.00	14.50	.....	17.00	13.00	780.00	10.00	.....	136.00	21.50	1,109.50
Granby.....	3.00	22.00	6.50	2.75	16.00	9.50	.....	13.50	17.00	800.00	.....	4.00	18.50	6.00	917.75
Gulford.....	5.00	12.00	.....	.....	50.50	.....	.....	.....	12.00	.....	.....	.....	20.25	.....	114.75
Harwinton.....	4.15	3.50	1.15	2.05	16.25	.....	2.20	40.50	15.25	.....	1.50	7.50	22.00	.....	114.10
New Milford.....	13.00	41.00	17.50	15.50	11.00	88.00	2.00	11.00	43.00	700.00	8.00	8.00	12.50	.....	914.50
Newtown.....	23.00	18.00	21.50	2.50	31.00	88.50	4.00	37.00	32.00	993.00	2.50	1.00	82.50	4.75	1,295.25
Putnam Park Ass'n.....	73.00	180.00	38.00	16.00	.....	.....	.....	.....	176.00	1,050.00	9.00	.....	211.25	.....	1,793.25
Rockville Fair Ass'n.....	.....	.....	.....	.....	.....	.....	.....	.....	8.00	1,793.83	.....	8.00	223.50	.....	2,037.33
Slmsbury.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	160.10
Southington.....	22.50	42.00	23.00	7.50	30.00	27.50	6.50	.....	38.00	260.00	14.00	3.00	96.00	20.00	533.00
Stafford Springs.....	76.00	114.00	71.00	49.00	27.00	23.00	.....	28.00	46.00	1,400.00	32.00	16.00	564.48	48.00	2,487.48
Suffield.....	59.00	.....	.....	.....	.....	.....	.....	.....	25.00	1,000.00	1.50	4.00	40.30	.....	1,140.50
Union (Monroe, etc.).....	6.25	13.00	13.00	1.00	64.50	82.00	5.00	.....	63.50	380.00	4.00	8.00	52.00	.....	647.25
Union (Somers, etc.).....	7.00	5.00	8.00	4.25	9.00	5.75	6.00	.....	29.00	.....	.....	1.00	51.05	14.40	139.45
Willimantic Fair Ass'n.....	.....	.....	.....	.....	.....	.....	.....	.....	77.50	1,155.00	.....	.....	.....	.....	1,232.50
Wolcott.....	53.25	69.25	14.75	18.75	58.00	10.00	3.50	.....	42.00	.....	9.00	2.00	50.50	27.00	283.50
Woodstock.....	19.80	93.60	56.80	24.00	28.50	24.00	.....	.....	90.60	170.00	14.40	15.60	45.00	.....	584.60
Conn. Hort. Soc.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Conn. Dairy Ass'n.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Conn. Pom. Soc.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

ANALYSIS OF PREMIUMS AND GRATUITIES.—CONTINUED. FARM PRODUCTS.

SOCIETIES.	Indian Corn.	Wheat.	Rye.	Barley.	Oats.	Beans.	Buckwheat.	Grass Seeds.	Potatoes.	Carrots.	Beets.	Turnips.	Turnips.	Onions.	Other products.	Total amount for Grain and Root Crops.
New London County...	\$0.75	\$1.50			\$1.50	\$0.25	\$1.00		\$3.75	\$0.75	\$0.50	\$0.50		\$1.50	\$3.25	\$11.25
Winham County...	5.50	7.25	\$1.25	\$1.00	.75	1.25	.75		22.50	.75	.75			1.75	6.75	42.50
Berlin...	1.00	1.00				1.50			16.75	1.75	5.00	\$0.25		3.50	26.25	66.00
Granford...	1.00		.50			1.50			9.00						2.00	12.50
Chester...	5.20	1.50	2.50	.50	2.50	5.00	1.75	\$1.00	3.50	1.70	1.65	.86		.86	16.65	38.10
Danbury...	11.00	1.50				2.00	1.75		33.50	8.00	6.00	1.25	7.75	13.25	43.00	185.50
Parmington Valley...	6.00	1.50	.50	.50	1.50	2.00		1.00	11.50	1.50	7.70	1.84	2.50	6.50	11.40	56.05
Granby...	10.75								1.00						5.65	7.40
Guilford...	9.50	.50	.50	.50	.50	1.00	.80		13.25	.75	.75		2.50	4.00	84.00	56.75
Harrison...	2.00	.50			1.00	1.50	.50		11.00		.75				6.00	31.00
New Milford...	2.00	.50	.75		1.00	.75	.50		18.25		.75				7.75	33.50
Newtown...	3.00		1.50		1.00	2.50	1.00		6.00	1.25	1.75	.75	2.00	1.25	13.50	31.50
Pacham Park Ass'n.									4.00	.50	.50			1.50	1.25	15.75
Rockville Fair Ass'n.																116.75
Shelbury...	8.50	1.25	.75	1.75	.25	1.50	.50		31.75	.75	2.00	.50	2.00	2.50	17.25	122.00
Southampton...	10.25		2.50	1.75	3.25	7.75	2.00		33.75	.75	3.50		5.50	6.50	17.25	194.10
Stafford Springs...	10.00		1.95			1.50	.25		30.50	.50		.25	1.00	2.25	32.50	83.50
Union (Monroe, etc.)...	5.00		.50				.50		20.25	.75	.75		.50	.75	9.50	138.50
Union (Salem, etc.)...	1.00								4.25							13.50
Willimantic Fair Ass'n.	4.25		.75			.50	.50		30.75	.50	1.50	.25	2.50	9.50	13.50	153.50
Woodstock...	5.10	.50	.90	.50	.50		.50		9.00	1.25	1.05	.25	.75	8.15	75	24.75
Conn. Hort. Soc.										.25	.25			.25	.50	1.00
Conn. Dairy Ass'n.																
Conn. Pom. Soc.																

* Farm and garden products, \$158.50.

ANALYSIS OF PREMIUMS AND GRATUITIES.—CONTINUED. FARM PRODUCTS.

SOCIETIES.	Fruits.		Flowers.	Other Cult. Crops.	Butter.	Cheese.	Honey and Wax.	Bread and Cake.	Sugar, Syrup, Preserved Fruit.	Agricultural Implements.	Mechanical Inventions.	Fine Arts and Fancy Articles.	Decorated Carts and Trains of Oxen.	Plowing at Exhibition.	Grange Exhibit.	Medals.	Diplomas.
New London County.....	\$3.80		\$2.50		\$4.00			\$5.75	\$0.75	\$5.00	\$69.50	\$65.00					
Windham County.....	\$7.95		\$2.40		4.50	\$4.50	\$1.75	15.15	9.00								
Berlin.....	40.50		1.50		4.50			11.50	4.50			31.75	\$6.00			11	
Braintree.....	11.50		1.50		2.00		2.00	3.00				14.50	3.00				
Cheshire.....	13.55		1.55		5.50		30	3.65	3.70		9.65	14.50	3.00				
Danbury.....	263.25		150.00	\$58.00	5.50	1.75	41.50	62.00	60.00		327.62	753.95	72.00				35
Farmington Valley.....	14.65		0.25	2.95				1.65	9.55			11.85					
Guilford.....	1.50		1.50	4.00	3.50			18.75	2.50			7.40					
Hartford.....	35.80		6.10		5.00			13.75				37.50	\$6.00				
Hartford.....	8.75		9.50				.70	5.30	3.35		9.85						
New Milford.....	49.00		5.50		5.50		5.50	5.50	3.25			67.75	24.00				
Peru.....	27.25		13.00		4.00		6.75	24.40	14.00			115.80					6
Putnam Park Ass'n.....	35.50		23.55		3.50		2.00	2.25		9.00	5.00	27.75					
Rockville Fair Ass'n.....	60.50				15.00							58.45	15.00				
Simsbury.....	69.90																
Southbury.....	87.50		5.25	19.25	3.00			10.00	14.80			37.85				2	
Stafford Springs.....	36.50		11.05		1.25	.35		13.60	7.95		5.00	59.55					14
Stafford.....	19.72		3.00		5.00					5.00		15.00					
Union (Monroe, etc.).....	39.25		18.35		2.25		1.25	22.00	1.75			7.25	21.50				9
Union (Somers, etc.).....	6.00				1.50			2.30	1.50	10.00		27.75	3.00				
Williamantic Fair Ass'n.....																	
Wolcott.....	19.75		2.00	2.75	1.50		.25	5.00	.75		9.50		5.00				
Woodstock.....	31.90		26.64	23.10	8.88	3.60	.90	12.72	2.10		12.75	34.80	8.40	\$16.80	\$15.00		4
Conn. Hort. Soc.....	9.50		\$48.00	14.75												6	
Conn. Dairy Ass'n.....					391.75												
Conn. Pom. Soc.....	105.50																

* Management of farms, \$10.00. † Children's exhibit, \$11.88; plowing at exhibition, \$16.80. ‡ Also amount paid for bicycle prizes, \$135.00. § Children's exhibit, \$9.75.

NUMBER OF ANIMALS EXHIBITED.

SOCIETIES.	Bulls.	Milch Cows.	Heifers.	Calves.	Working Oxen (pairs).	Draft Oxen (pairs).	Steers (pairs).	Rat Cattle.	Horses—except speed.	Horses—speed.	Sheep.	Swine.	Poultry (coops).	All other Stock.
New London County.....	23	146	16	12	18	10	13	11	58	..	120	9	55	..
Windham County.....	44	22	71	41	20	3	28	6	40	..	43	39	23	..
Berlin.....	5	94	6	7	1	3	2	1	51	8	18	11	13	..
Stratford.....	1	10	..	1	3	4	..	1	11	..	..	10	96	..
Cheshire.....	1	4	..	1	2	..	..	..	7	..	..	..	10	..
Danbury.....	52	101	58	25	48	..	41	1	77	96	36	30	284	2 herds.
Farmingdon Valley.....	11	39	20	9	13	9	15	..	9	..	19	..	147	..
Grainby.....	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Gaillard.....	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Harston.....	6	6	4	9	40	..	..	4	11	..	7	24	75	..
New Milford.....	6	25	23	16	4	7	53	1	37	..	12	8	352	..
Newtown.....	18	25	21	13	37	13	49	4	33	..	6	..	..	..
Pittsford Fair Ass'n.....	17	93	43	16	..	..	..	..	18	39	1	..	11	..
Rochester Fair Ass'n.....	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Shutbury.....	17	30	18	13	13	..	13	9	32	11	17	10	158	..
Stafford.....	20	53	43	25	9	12	10	..	23	..	18	6	..	..
Stafford Springs.....	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Summerville.....	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Union (Monroe, etc.).....	5	6	8	2	34	..	13	4	21	..	6	1	53	..
Union (Seneca, etc.).....	8	20	5	4	9	..	4	..	16	20	..	..	148	..
Williston Fair Ass'n.....	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Williston Fair Ass'n.....	..	60	13	19	40	..	10	8	31	..	15	2	163	12
Woodstock.....	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Woodstock.....	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Conn. Hort. Soc.....	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Conn. Dairy Ass'n.....	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Conn. Pom. Soc.....	..	..	..	..	..	..	..	..	..	..	..	..	..	..

AGRICULTURAL FAIRS IN CONNECTICUT.—1898.

SOCIETIES.	PLACE.	DATE.	ATTENDANCE.					
			Monday.	Tuesday.	Wednesday. day.	Thursday.	Friday.	Saturday.
New London County.....	Norwich.....	Sept. 5-7.....	3,000	3,500	1,000	1,100	.....	7,500
Windham County.....	Brooklyn.....	Sept. 13-15.....	.....	.....	2,200	.....	.....	2,300
Berlin.....	Berlin.....	Sept. 21.....	.....	.....	1,900	.....	.....	1,800
Branford.....	Branford.....	Sept. 21.....	.....	.....	1,500	.....	.....	1,500
Chester.....	Chester.....	Sept. 28.....	.....	.....	650	.....	.....	650
Danbury.....	Danbury.....	Oct. 2-8.....	3,939	3,933	3,788	17,547	17,700	3,944
Farmington Valley.....	Collinsville.....	Sept. 7-8.....	.....	.....	1,500	3,500	.....	49,680
Granby.....	Granby.....	Sept. 28-29.....	.....	.....	880	2,900	.....	8,000
Gulfport.....	Gulfport.....	Sept. 28.....	.....	.....	.....	.....	.....	3,050
Harwinton.....	Harwinton.....	Oct. 4.....	12,000	.....	.....	.....	.....	12,000
New Milford.....	New Milford.....	Sept. 6-8.....	800	2,400	2,400	1,000	.....	2,700
Newtown.....	Newtown.....	Sept. 27-29.....	1,000	4,000	4,000	3,000	.....	8,000
Putnam.....	Putnam.....	Aug. 30-31, Sept. 1.....	1,100	7,000	7,000	3,100	.....	11,800
Rockville Fair Ass'n.....	Rockville.....	Aug. 30-22.....	600	2,000	2,000	4,500	.....	7,100
Simsbury.....	Simsbury.....	Oct. 5-6.....	.....	2,200	2,600	.....	.....	4,800
Southington.....	Southington.....	Sept. 27-28.....	2,200	2,000	2,600	8,000	3,600	13,500
Stafford Springs.....	Stafford Springs.....	Oct. 4-6.....	.....	.....	Rain.	.....	.....	.....
Suffield.....	Suffield.....	Sept. 20-21.....	.....	.....	.....	.....	.....	.....
Union (Monroe, etc.).....	Huntington.....	Sept. 21-22.....	.....	.....	6,000	1,000	.....	7,000
Union (Somers, etc.).....	Enfield.....	Sept. 28-29.....	.....	500	6,000	1,000	.....	7,500
Willimantic Fair Ass'n.....	Willimantic.....	Sept. 27-29.....	.....	.....	.....	.....	.....	8,000
Wolcott.....	Wolcott.....	Oct. 12.....	.....	1,923	1,583	.....	.....	8,006
Woodstock.....	South Woodstock.....	Sept. 30-31.....	.....	.....	.....	.....	.....	1,980
Conn. Hort. Soc.....	Hartford.....	* Jan. 18-20.....	.....	.....	.....	.....	.....	400
Conn. Dairy Assn.....	Hartford.....	.....	.....	.....	.....	.....	.....	.....
Conn. Pom. Soc.,.....	Wallingford.....	Oct. 13.....	.....	.....	.....	.....	.....	.....

* April 6-7, June 22-23, July 28, Sept. 21-22, Nov. 8-10.

OFFICIAL LIST OF FARMERS' CLUBS IN CONNECTICUT, 1898-99.

NAME OF CLUB.	PRESIDENT.	SECRETARY.
New Haven County....	Prof. Wm. H. Brewer.	Cullen B. Foote.
Cheshire.....	Alfred S. Bennett,....	Fred Doolittle.
East Windsor.....	Lemuel Stoughton, Jr.	John F. Fitts.
Green's Farms.....	J. H. Jennings.....	S. B. Sherwood.
Greenwich.....	S. R. Close.....	G. A. Lockwood.
Naugatuck.....	J. B. Tolles.....	L. W. Kane.
Newington.....	H. A. Whittlesey.....	J. S. Kirkham.
New Britain.....	L. S. Wells.....	A. C. Blake.
Wilton.....	D. N. Van Hoosear....	J. C. Dudley.

CONNECTICUT DAIRYMEN'S ASSOCIATION.

ADRIAN R. WADSWORTH, *Pres't*, Farmington.F. H. STADTMUELLER, *Sec'y*, Elmwood.W. I. BARTHOLOMEW, *Treas.*, Putnam.

CONNECTICUT POMOLOGICAL SOCIETY.

J. H. HALE, *Pres't*, S. Glastonbury.H. C. C. MILES, *Sec'y*, Milford.

CONNECTICUT HORTICULTURAL SOCIETY.

J. T. WITHERS, *Pres't*.C. H. BOYKETT, *Sec'y*.C. H. WILEY, *Treas.*

CONNECTICUT JERSEY CATTLE BREEDERS' ASSOCIATION.

S. C. COLT, *Pres't*, Elmwood.R. A. POTTER, *Sec'y*, Bristol.B. W. COLLINS, *Treas.*, Meriden.

CONNECTICUT CREAMERY ASSOCIATION.

E. A. RUSSELL, *Pres't*, Suffield.FRANK AVERY, *Sec'y and Treas.*, Wapping.

CONNECTICUT SHEEP BREEDERS' ASSOCIATION.

R. S. HINMAN, *Pres't*, Oxford.JOHN H. WADHAMS, *Sec'y*, Goshen.

CONNECTICUT FORESTRY ASSOCIATION.

E. V. PRESTON, *Pres't*, Hartford.Miss MARY WINSLOW, *Sec'y and Treas.*, Westogue.

THE AUDUBON SOCIETY OF CONNECTICUT.

Mrs. JAMES OSBORNE WRIGHT, *Pres't*, Fairfield.Mrs. HELEN S. GLOVER, *Sec'y and Treas.*, Fairfield.

THE CONNECTICUT BEE-KEEPER'S ASSOCIATION.

G. H. YALE, *Pres't*.Mrs. W. E. RILEY, *Sec'y*, Waterbury.

CONNECTICUT STATE POULTRY SOCIETY.

GEORGE B. FISHER, *Pres't*, Hartford.R. G. BAILEY, *Sec'y*, Hartford.

WESTERN CONNECTICUT POULTRY ASSOCIATION.

E. B. PARSONS, *Pres't*, West Winsted.H. J. PIERRE, *Sec'y*, Winsted.

MERIDEN POULTRY ASSOCIATION.

L. E. COE, *Pres't*. JOSHUA SHUTE, *Sec'y*. W. B. HALL, *Treas.*

NEW HAVEN POULTRY ASSOCIATION.

EDWARD A. TODD, *Pres't*.W. R. KIRKWOOD, *Sec'y*.EDW. L. JONES, *Treas.*

THE AUDUBON SOCIETY OF CONNECTICUT.

Mrs. JAMES OSBORNE WRIGHT, *Pres't*, Fairfield.Mrs. HENRY S. GLOVER, *Cor. Sec'y and Treas.*

CONNECTICUT BEE KEEPERS' ASSOCIATION.

G. H. YALE, *Pres't*.Mrs. W. E. RILEY, *Sec'y*, Waterbury.

OFFICIAL DIRECTORY

OF THE

CONNECTICUT PATRONS OF HUSBANDRY,

FOR 1898.

OFFICERS OF THE STATE GRANGE.

Master, STEPHEN O. BOWEN, Eastford.
 Overseer, G. C. BECKWITH, Nepaug.
 Lecturer, MRS. E. H. BARNES, Southington.
 Steward, JOEL H. BREWER, Hillstown.
 Assistant Steward, H. C. C. MILES, Milford.
 Chaplain, REV. D. B. HUBBARD, Little River.
 Treasurer, NORMAN S. PLATT, New Haven.
 Secretary, HENRY E. LOOMIS, Glastonbury.
 Gate Keeper, HENRY W. MORSE, Jewett City.
 Ceres, MRS. M. C. GAYLORD, Box 1108, Bristol.
 Pomona, MRS. MARY J. BROOKS, Clinton.
 Flora, MRS. J. M. ROBINSON, Box 808, Webster, Mass.
 Lady Steward, MRS. F. B. CRANDALL, Farmington.

EXECUTIVE COMMITTEE.

J. H. HALE, South Glastonbury,	Term Expires,	1900.
B. C. PATTERSON, Torrington,	" "	1901.
ORSON S. WOOD, Ellington,	" "	1902.
S. O. BOWEN, Eastford, <i>ex officio</i> ,	" "	1900.
HENRY E. LOOMIS, <i>ex officio</i> ,	" "	1900.

FINANCE COMMITTEE.

LEVI S. WELLS, New Britain. TIMOTHY SEDGWICK, West Hartford.
 HENRY T. DAYTON, Watertown.

OFFICERS OF THE GRANGES.

NAME.	MASTER.	LECTURER.	SECRETARY.
POMONA GRANGES.			
Central Pomona, No. 1.	C. Eugene Adams, Wethersfield,	Robert W. Andrews, New Britain,	Chas. E. Bacon, Middletown.
Quinebang Pomona, No. 2.	P. B. Sibley, Danielson,	Mrs. Lisa K. Fuller, Scotland,	L. H. Healy, N. Woodstock.
East Central Pomona, No. 3.	J. E. Collins, Wapping,	O. S. Wood, Ellington,	Mrs. Laura J. Brewer, Hillstown.
Mountain County Pomona, No. 4.	Geo. S. Hammond, W. Goshen,	Wm. C. D. Allen, Wallingford,	N. S. Stevens, East Canaan.
New Haven Co. Pomona, No. 5.	H. C. C. Miles, Milford,	J. E. Hall, Colchester,	Mrs. L. P. Tuttle, North Haven.
New London Co. Pomona, No. 6.	J. B. Bliven, North Franklin,	Mrs. Mary Phipps, Prospect,	H. W. Morse, Jewett City.
Excelsior Pomona, No. 7.	F. M. Candee, Nangatuck,	John S. Dickinson, Saybrook,	Cyrus D. Everts, Killingworth.
Seaview Pomona, No. 8.	A. E. Olmstead, East Haddam,	Mrs. F. E. Blakeman, Oronoque,	Cyrus D. Everts, Killingworth.
Fairfield County Pomona, No. 9.	I. C. Fanton, Westport,		Vanderbilt Godfrey, Norwalk.
SUBORDINATE GRANGES.			
Granby, No. 5.	Frederick J. Jewett, North Granby,	Mrs. Ellen S. White, No. Granby,	Lydia C. Loveland, No. Granby.
Washington, No. 11.	R. W. Squires, Washington Depot,	Miss Mina Rylander, Wash. Depot,	Mrs. C. C. Ford, Washington Depot.
East Granby, No. 12.	C. H. Hanchett, East Granby,	Edward Knechtler, Suffolk,	Mrs. Mary E. Lobdell, East Granby.
Tuxis, No. 13.	T. E. Griswold, Bloomfield,	F. L. Granger, Jr., Bloomfield,	A. C. Case, Bloomfield.
Hope, No. 18.	K. K. Kimberley, West Torrington,	H. J. Newberry, Torrington,	Mrs. Grace Kimberley, W. Torrington.
Lebanon, No. 21.	Clifton Peck, Yantic,	Mrs. Mary S. W. Throop, Lebanon,	N. S. Loomis, Lebanon.
Advance, No. 22.	J. C. Eddy, Simsbury,	George Patterson, Simsbury,	Mrs. Hattie H. Eno, Simsbury.
Cheshire, No. 23.	Graham A. Hitchcock, Cheshire,	Georgia M. Pardee, Cheshire,	Chas. T. Hotchkiss, W. Cheshire.
Berlin, No. 24.	C. H. Risley, Berlin,	Mrs. H. B. Bushnell, Berlin,	Jas. E. Beale, Berlin.
Union, No. 25.	John C. Friable, Southington,	Mrs. Mary Moore, Southington,	Mrs. E. H. Barnes, Southington.
Glastonbury, No. 26.	Geo. H. Carrier, Glastonbury,	Stanciliff Hale, South Glastonbury,	H. B. Rising, So. Glastonbury.
Suffield, No. 27.	John R. Henshaw, Mapleton,	Arthur Sikes, Mapleton,	Leroy H. Sikes, Mapleton.
Meriden, No. 28.	Wm. B. Rice, Meriden,	Mrs. J. H. Francis, Meriden,	J. H. Francis, Meriden.
Wapping, No. 29.	Thomas Newberry, Buckland,	Walter N. Foster, Wapping,	Mrs. Sarah J. Collins, Wapping.
Manchester, No. 30.	J. S. Cushman, South Manchester,	Mrs. Kate Loomis, So. Manchester,	K. B. Loomis, South Manchester.
North Cornwall, No. 31.	Hubert M. Pratt, West Cornwall,	Miss Adèle T. Peck, West Cornwall,	Mrs. Niles Scoville, West Cornwall.
Wallingford, No. 32.	Geo. A. Hopson, East Wallingford,	Mrs. C. A. D. Allen, Wallingford,	Geo. H. Bronson, Northford.
Canaan, No. 33.	F. A. Bidwell, Canton Center,	John Crowley, Canton,	A. W. Bristol, Jr., Canton Center.
North Haven, No. 34.	Hubert F. Potter, Montowese,	Mrs. L. P. Tuttle, North Haven,	Charles H. Thorpe, North Haven.
Little River, No. 35.	Lawrence V. Lester, Silver Lane,	Mrs. Gertrude Miller Lane,	Mrs. N. C. Cleveland, Hampton.
East Hartford, No. 36.	W. F. Waterbury, North Stamford,	C. R. Risley, Silver Lane,	Laura M. Griswold, Hockanum.
New Canaan, No. 37.	Arthur C. Blake, New Britain,	Rev. J. H. Hoyt, New Canaan,	Mrs. Stella St. John, New Canaan.
Burrill, No. 38.	W. H. Chandler, South Woodstock,	Robt. W. Andrews, New Britain,	Mrs. C. M. Fanning, New Britain.
Semex, No. 39.	Chas. J. Hubbard, Middletown,		Wm. A. Weaver, South Woodstock.
Matadawsett, No. 40.	C. D. Hyde, Brooklyn,	Mrs. Rose D. Gilbert, Middletown,	Miss Fannie W. Prior, Middletown.
Brooklyn, No. 41.		J. E. Stetson, Brooklyn,	H. D. Crosby, Brooklyn.

Newington,	44	DeForrest E. Turner, Newington,	Miss Mary L. Luce, New Britain,	Samuel H. Kilbourne, Newington.
Ellington,	46	Orson S. Wood, Ellington,	Mason P. Ellsworth, Windsorville,	George Knowles, Ellington.
Bolton,	47	Geo. Curtis Andover,	Miss Anna M. Alvord, Bolton,	Miss Mand White, Bolton.
Whitville,	48	Dwight E. Mills, Whitville,	Mrs. Helen Hart, Whitville,	George W. Hart, Unionville.
Wesfield,	50	F. E. Boardman, Little River,	Rev. D. B. Hubbard, Little River,	Mrs. Robt. F. Addis, Little River.
Tolland,	51	Fred S. Menchan, Rockville,	Mrs. Abbie F. Hurlbut, Rockville,	Chas. J. H. Lathrop, Rockville.
Vernon,	52	O. S. Grover, Vernon Center,	Mrs. Alice E. Hart, Vernon Center,	Miss J. H. Lathrop, Vernon Center.
Poquonock,	53	Eli S. Hough, Poquonock,	A. H. Clark, Poquonock,	Mrs. Alice J. Alford, Poquonock.
Plainville,	54	C. M. Woodford, Plainville,	Miss S. E. Buckley, Forestville,	Mrs. E. M. Baker, Plainville.
Stafford,	55	J. M. Larned, Stafford Springs,	Mrs. J. C. Crawford, Staffordville,	Mrs. Clara E. Beard, Stafford.
East Haddam,	56	C. W. Coe, Durham Center,	George B. Hall, Moodus,	Samuel E. Williams, Moodus.
Durham,	57	P. E. Coe, Durham Center,	Miss Lena Sage, Durham Center,	F. P. Brainerd, Durham Center.
West Hartford,	58	Paul Thomson, West Hartford,	Mrs. Kate E. Way, West Hartford,	Mrs. Fannie A. Clark, West Hartford.
Saybrook,	59	John S. Dickenson, Saybrook,	Mrs. Ida H. McAllister, Saybrook,	Mrs. Mary J. Parsons, Saybrook.
Crystal Lake,	60	Henry Trowbridge, Eastford,	Clinton M. Jones, Eastford,	Arthur M. Keith, Eastford.
Wolf Den,	61	Francis H. Bird, Abington,	Walter A. Averill, Pomfret Center,	Mrs. E. S. Estabrooks, Abington.
Eureka,	63	M. D. Merrill, Nepaug,	G. C. Beckwith, Nepaug,	Miss Clara E. Smith, Middlefield.
Middlefield,	64	Alfred H. Angur, Middlefield,	Miss Grace E. Miller, Middlefield,	B. F. Koons, Storrs.
Manfield,	65	Dr. M. S. Mayo, Storrs,	Mrs. Mary L. Mayo, Storrs,	Mrs. Clara L. Mills, Wilsonville.
Quinniacet,	66	Burton S. Upham, Wilsonville,	Mrs. J. E. Law, Thompson,	Mrs. E. R. Parmelee, Killingworth.
Killingworth,	67	Chas. N. Davis, Killingworth,	David K. Stevens, Killingworth,	Miss Hattie M. Hubbard, Cromwell.
Cromwell,	68	Geo. S. Butler, Cromwell,	Caleb S. Pease, Cromwell,	Miss Edna L. Clark, Scotland.
Shelucket,	69	Jonathan Anthony, Scotland,	Miss Mary A. Smith, Scotland,	Levi N. Clark, So. Canterbury.
Canterbury,	70	E. E. Barrows, South Canterbury,	Martin Lyon, Canterbury,	Geo. F. Hare, Terryville.
Mad River,	71	Arden H. Coe, Waterbury,	A. J. Pierpont, Waterbury,	Fred M. Smith, Milford.
Plymouth,	72	Frederick L. Tolles, Plymouth,	Mrs. Abbey C. Smith, Plymouth,	W. L. Wetmore, Winchester.
Indian River,	73	Walter L. Merwin, Milford,	H. C. C. Miles, Milford,	E. H. Cook, Andover.
Winchester,	74	W. L. Goodenough, Winchester,	Florence L. Wetmore, Winchester,	Clifford H. Everts, Clinton.
Covertry,	75	H. B. Pomeroy, Coventry,	Andrew Kingsbury, Coventry,	Mrs. Hattie J. Strong, Colchester.
Andover,	76	Edgar D. White, Andover,	Mrs. Amy Perkins, Andover,	George Meacham, Stratford.
Clinton,	77	William H. Kelsey, 2d, Clinton,	Mrs. Mary J. Brooks, Clinton,	Eleanor C. Turner, Colebrook.
Colchester,	78	Carroll E. Staples, Colchester,	Henry I. Stebbins, Colchester,	Frank M. Sperry, New Haven.
Housatonic,	79	Frank S. Hopson, Stratford,	Herbert W. Sniffin, Stratford,	Mrs. Ella L. Loomis, S. Coventry.
Colebrook,	82	Lester N. Smith, Mill Brook,	Arthur E. Pascoe, Winsted,	H. V. D. Reed, America Union, N. Y.
Foxon,	84	A. F. Sperry, New Haven,	L. D. Granniss, New Haven,	Joel H. Fowler, Hillstown.
Wagrumburg,	85	Engene Hutchinson, South Coventry,	DeWitt Kingsbury, So. Coventry,	John E. Tanner, Campbell's Mills.
Webank,	86	Sanford Northrop, Leedsville, N. Y.,	Myron B. Benton, Leedsville, N. Y.,	Bert H. Gardner, Warrenville.
Hillstown,	87	F. N. Buckland, Hillstown,	Mrs. Laura J. Brewer, Hillstown,	Edw. C. Shelton, Steepney.
Ekok,	88	Wm. N. Sweet, Oneco,	Rev. Austin Gallup, Oneco,	C. B. Pomeroy, Jr., Williamantic.
Ashford,	89	Wilbur Lanphear, Ashford,	H. H. Wheeler, Monroe,	C. B. Pomeroy, Jr., Williamantic.
Harmony,	90	Amrose S. Hurd, Monroe,	Geo. H. Andrews, Williamantic,	C. C. Palmer, Jewett City.
Border,	92	L. Stoughton, Jr., E. Windsor Hill,	J. Samuel Allen, East Windsor,	Edwin L. Wood, Putnam.
East Windsor,	93	H. W. Morse, Jewett City,	H. M. Miner, Jewett City,	
Jewett City,	94	Elmer C. Wood, Putnam,	Mrs. Rachel Warren, Putnam,	
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OFFICERS OF THE GRANGES.—CONTINUED.

NAME.	MASTER.	LECTURER.	SECRETARY.
SUBORDINATE GRANGES.—			
98, Barkhamsted,	Wallace Case, Barkhamsted,	Mrs. Burton Tiffany, Barkhamsted,	F. B. Tiffany, Barkhamsted.
99, Barnden,	Willis M. Cook, Mt. Carmel Center,	O. L. Smith, New Haven,	E. B. Alling, New Haven.
100, Taghannuck,	Chas. C. Dean, Ellsworth,	Mrs. Alida C. Buckley, Ellsworth,	Mrs. E. R. Everett, Ellsworth.
101, Mashapung Lake,	H. F. Corbin, Stafford Springs,	L. M. Reed, Union,	Mrs. Georgia B. Reed, Stafford Spgs.
102, Beacon Valley,	Jerome A. Davis, Jr., Westville,	Mrs. Josephine N. Downs, Westville,	E. A. Hotchkiss, Naugatuck.
103, Somers,	Merritt A. Davis, Somers,	Mrs. Bertha F. Avery, Somers,	Erwin D. Avery, Somers.
104, East Haven,	R. H. Coe, East Haven,	C. J. Upson, New Haven,	H. D. Curtiss, East Haven.
105, Litchfield,	F. A. Stoddard, Litchfield,	Fred A. Stoddard, Litchfield,	Fred L. Tharp, Litchfield.
106, Woodbridge,	Erroll M. Angur, Westville,	Miss Elma I. Angur, Westville,	Miss Helen M. Warner, Westville.
107, East Hampton,	E. W. Day, East Hampton,	Mrs. Lizzie A. Hall, East Hampton,	Miss Katie Jones, East Hampton.
108, Preston City,	Hollis H. Palmer, Preston,	Wm. D. Bagley, Preston,	Miss Fannie F. Fitch, Preston.
109, Killingly,	Chas. H. Pellet, Danielson,	Mrs. Alice E. Wilbur, Danielson,	Walter F. Day, Danielson.
110, Highland,	A. A. Tillinghast, So. Killingly,	Miss Emily P. Tubbs, So. Killingly,	Mrs. F. A. Sanderson, Moosup.
111, Wethersfield,	Dudley Wells, Wethersfield,	Miss May Blumenthal, Wethersfield,	Dudley Wells, 2d, Wethersfield.
112, Rocky Hill,	L. B. Williams, Rocky Hill,	Mrs. Jane E. Blinn, Rocky Hill,	William Warner, Rocky Hill.
113, Bristol,	Elbert W. Gaylord, Bristol,	Walter H. Blair, Bristol,	James Pettibone, Bristol.
114, Unity,	Geo. W. Spicer, Deep River,	Miss Helen Post, Deep River,	Mrs. Flora M. Dudley, Deep River.
115, Beacon,	Elbert A. Hopkins, Northfield,	L. Gardner Humphreys, Northfield,	Mrs. Allie L. Nearing, Northfield.
116, Morris,	Chas. B. Ray, Morris,	Frederick Stockman, East Morris,	Geo. Alvord, Morris.
117, Madison,	Geo. E. Whedon, Madison,	Mrs. Laura E. Whedon, Madison,	Miss Jennie M. Whedon, Madison.
118, Bethlehem,	Richard Magee, Bethlehem,	Geo. C. Stone, Bethlehem,	Wallace P. Hayes, Bethlehem.
119, Watertown,	Orrin D. Estey, Watertown,	Mrs. Alice Barber, Watertown,	Mrs. Celia S. Peck, Watertown.
120, Westbrook,	David C. Dibble, Westbrook,	Horace E. Kelsey, Westbrook,	Daniel W. Grosvenor, Westbrook.
121, Higganum,	Myron G. Skinner, Higganum,	Leroy A. Smith, Higganum,	Robt. H. Freeman, Higganum.
122, Hollenbeck,	Levi Ganser, Huntsville,	M. F. Skelley, Woodbury,	Mrs. Lois Pendleton, South Canaan.
123, Pleasant Valley,	E. M. Barnes, North Woodbury,	Mrs. Chas. J. Goodale, Glastonbury,	Miss Mattie Barnes, No. Woodbury.
124, Goodwill,	Chas. J. Goodale, Glastonbury,	Mrs. Henry M. Clark, Milford,	Harold B. Waldo, Naubuc.
125, Orange,	Carleton V. Woodruff, Orange,	John J. Northrup, Newtown,	Josephine T. Clark, Orange.
126, Pottatuck,	K. L. Coleman, Newtown,	Mrs. Annie Gordon, Shelton,	C. B. Johnson, Newtown.
127, Farmill River,	Nicholas Wakelee, Shelton,	Miss Lou Estella Hills, Columbia,	Miss E. L. Wooster, Huntington.
128, Columbia,	Herbert P. Collins, Columbia,	Mrs. Belle Johnson, Warren,	Max Schnell, Warren.
129, Wichita,	Austin R. Humphrey, Warren,	Simon C. Bradley, Greenfield Hill,	Benj. F. Pease, Jr., Greenfield Hill.
130, Greenfield Hill,	Wakeman Burr Hill, Greenfield Hill,	Joseph M. Tucker, Trumbull,	Wm. H. Brinsmade, Nichols.
131, Trumbull,	Plumb B. Nichols, Trumbull,	Miss Mary Merwin, Sharon,	Miss Kate B. Whitford, Sharon.
132, Silver Lake,	Joseph J. Ryan, Sharon,	Miss Clara M. Bottom, East Canaan,	Miss Carrie E. Brinton, East Canaan.
133, East Canaan,	Geo. K. Goodwin, East Canaan,	Mrs. C. H. Brown, Willington,	A. H. Eldredge, Willington.
134, Willington,	F. W. Pratt, W. Willington,		

Middlebury,
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John T. Basham, Middlebury,
Daniel F. Green, Plainfield,
Fred H. Beers, Hawleyville,
Olin D. Buckingham, Beacon Falls,
Henry G. Wright, West Goshen,
David B. Hoickkiss, Prospect,
J. S. Bedell, Stamford,
Horace Hurlbutt, Weston,
Stephen P. Sterling, Hamburg,
Wm. J. Wood, Westport,
Geo. S. Gillette, Adams,
Chas. H. Potter, N. Woodstock,

Mrs. Martha Judd, Middlebury,
Mrs. Mary E. Bishop, Plainfield,
Rev. C. W. Francis, B. Center,
Mrs. Mary R. Clark, Beacon Falls,
Mrs. Emma P. Adams, W. Goshen,
Geo. H. Cowdell, Union City,
Mrs. L. B. Martin, High Ridge,
Mrs. T. W. Treadwell, Lyons Plain,
Mrs. Lizzie E. Beebe, Hamburg,
J. Frank Elwood, Green's Farms,
Mrs. Ellie E. Gillette, Adams,
Cora E. Wetherell, East Woodstock.

A. S. Clark, Middlebury.
David C. Kinne, Plainfield.
Henry W. Griffen, Hawleyville.
Fred L. Colvin, Beacon Falls.
Frederick W. Lucas, West Goshen.
Mrs. Sarah S. Talmadge, Prospect.
Miss Lucy R. Walker, Long Ridge.
Vanderbilt Godfrey, Norwalk.
J. Warren Stark, North Lyme.
Joseph Adams, Westport.
Geo. B. Beers, Plainville.
Chester E. May, East Woodstock.

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Connecticut Board of Agriculture,

1866—1898.

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STATE OF CONNECTICUT.

ELEVENTH ANNUAL REPORT

OF THE

STORRS

AGRICULTURAL EXPERIMENT STATION,

STORRS, CONN.

1898

Printed by Order of the General Assembly.

Hartford Press

THE CASE, LOCKWOOD & BRAINARD COMPANY

1899

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OF THE
STORRS AGRICULTURAL COLLEGE.

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The Station is located at Mansfield (P. O. Storrs), as a department of the Storrs Agricultural College. The chemical and other more abstract research is carried out at Wesleyan University, Middletown, where the Director may be addressed.

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Report of the Executive Committee.

To His Excellency GEORGE E. LOUNSBURY,
Governor of Connecticut.

In accordance with the resolution of the General Assembly concerning the congressional appropriations to Agricultural Experiment Stations, and an Act of the General Assembly approved March 19, 1895, relating to the publication of the Reports of the Storrs Agricultural Experiment Station, we have the honor to present herewith the Eleventh Annual Report of that Station, namely, that for the year 1898.

The accompanying report of the Treasurer gives the details of receipts and expenditures. We refer you to the report of the Director and his associates for a statement of the work accomplished during the past year. We are confident that the funds have been wisely expended and that the work accomplished is such as will result in great benefit to our agricultural and other interests.

Respectfully submitted,

T. S. GOLD,
W. E. SIMONDS,
G. W. FLINT,

Executive Committee.

Report of the Treasurer

FOR THE FISCAL YEAR ENDING JUNE 30, 1898.

The following summary of receipts and expenditures, made out in accordance with the form recommended by the United States Department of Agriculture, includes, first, the Government appropriation of \$7,500, and, secondly, the annual appropriation of \$1,800 made by the State of Connecticut, together with various supplemental receipts. These accounts have been duly audited according to law, as is shown by the Auditors' certificates, copies of which are appended.

GOVERNMENT APPROPRIATION — RECEIPTS AND EXPENDITURES.

RECEIPTS.	
United States Treasury,	\$7,500 00
EXPENDITURES.	
Salaries,	\$3,918 36
Labor,	1,246 50
Publications,	27 23
Postage and stationery,	262 95
Freight and express,	68 43
Heat, light, and water,	282 10
Chemical supplies,	140 05
Seeds, plants, and sundry supplies,	287 71
Fertilizers,	130 83
Feeding stuffs,	266 42
Library,	45 52
Tools, implements, and machinery,	21 45
Furniture and fixtures,	127 50
Scientific apparatus,	255 94
Live stock,	16 90
Traveling expenses,	360 27
Contingent expenses,	10 00
Building and repairs,	31 84
Total,	\$7,500 00

STATE APPROPRIATION AND SUPPLEMENTAL RECEIPTS — RECEIPTS AND EXPENDITURES.

RECEIPTS.	
State of Connecticut,	\$1,800 00
Miscellaneous receipts,	400 00
Total,	\$2,200 00

EXPENDITURES.	
Salaries,	\$878 58
Labor,	603 11
Postage and stationery,	30 19
Freight and express,	17 15
Heat, light, and water, including electric power,	107 20
Chemical supplies,	10 45
Bacteriological investigations,	300 00
Seeds, plants, and sundry supplies,	111 73
Tools, implements, and machinery,	50 .
Furniture and fixtures,	62 .
Scientific apparatus,	60 13
Live stock,	2 50
Traveling expenses,	11 04
Contingent expenses,	2 00
Building and repairs,	64 80
Total,	\$2,200 00

HENRY C. MILES, *Treasurer.*

AUDITORS' CERTIFICATES.

MILFORD, CONN., January 26, 1899.

This certifies that we have examined the accounts of Henry C. Miles, Treasurer of Storrs Agricultural Experiment Station, for the fiscal year ending September 30, 1898, for the investigation of food economy, compared them with the vouchers and found them correct. The amount of the annual appropriation received and expended was eighteen hundred dollars.

FRANKLIN B. NOYES,
D. WARD NORTHROP,
Auditors of Public Accounts.

This certifies that we have this day examined the accounts of Henry C. Miles, Treasurer of the Storrs College Experiment Station for the fiscal year ending June 30, 1898, and have compared said accounts with the vouchers and found the same to be correct, showing receipts and expenditures both amounting to the equal sum of \$7,900, and no balance remaining on hand.

THEODORE S. GOLD,
W. E. SIMONDS,
Auditors of Storrs College.

Hartford, August 19, 1898.

Report of the Director for the Year 1898.

The work of the Station during the past year has been along the lines followed for several previous years. The principal subjects of inquiry have been the effects of fertilizers upon the growth and composition of plants, dairy bacteriology, the feeding of cows and sheep, and the food and nutrition of man.

EXPERIMENTS UPON THE EFFECTS OF FERTILIZERS ON THE PROPORTION OF NITROGEN IN PLANTS, AND UPON THE AMOUNT OF THE CROPS PRODUCED.

These experiments have been made with grasses of different kinds, oats, corn, potatoes, cow peas, and soy beans, grown in field and garden plots, and in pots. The experiments in field and garden plots have been in progress for a number of years, and results have been published in previous Reports of the Station. In the field experiments during the early years, attention was given to the amounts and composition of the crops provided with different fertilizers. For two or three years past more especial attention has been devoted to the effects of mineral and nitrogenous fertilizers upon the proportions of nitrogen in the plants grown, with their use both in field and garden plots. Pot experiments for the study of the same question have been lately undertaken.

DAIRY BACTERIOLOGY — BOVINE TUBERCULOSIS.

The inquiries in these lines have had reference to two general topics; bovine tuberculosis, and the effects of bacteria in the handling of milk and the making of butter and cheese. The experimental work of the past year has been carried on by Mr. Esten, who has for several years been the assistant of Prof. Conn. The most important contribution, however, has been made by Prof. Conn, who has improved a year's stay in Europe to visit universities, bacteriological laboratories, hygienic institutes, experiment stations, and dairying establishments in England, Holland, Denmark, Germany, Switzerland,

and Italy. The results of Prof. Conn's observations on bovine tuberculosis are epitomized in Bulletin No. 19 of the Station, on "The Present Condition of Bovine Tuberculosis in Europe." They are given in more detail in an article on the same subject in the present Report. Another article by Prof. Conn gives the results of his observations on the practical applications of bacteriology in European dairying, especially in the handling of milk and the making of butter and cheese.

Much more attention has been given to these subjects by bacteriologists and practical dairymen in Europe than in the United States. The results of this foreign experience as collated by a specialist, with such unusual opportunity for personal observation, can hardly fail to be of particular interest to farmers in Connecticut and elsewhere. A large amount of space is accordingly given to them in the present Report.

The experiments with tuberculous cows at the Station, of which an account was given in the Report for 1897, have been continued. Some of the more important and interesting results of these investigations are given in the present Report. These experiments will be continued during the coming year.

The experiments on the bacteria of milk and cream and their influence on butter-making, which have been carried on by Prof. Conn and his assistants for several years, and have been described in the Reports of the Station, are being continued.

FEEDING OF COWS AND SHEEP.

The studies of the rations fed to milch cows, and their effects upon milk production, which have been carried out for several years past with the Station herd and with private herds in different parts of the State, have been continued, but on a plan somewhat different from that of previous years. The length of the individual experiments has been increased to three months. During the first half of this period the rations found in previous use were continued, and during the last half a new ration, suggested by the Station, was adopted. These later rations were determined according to the milk-producing capacities of the cows rather than their avoirdupois weights, for reasons described in detail in the Report of last year. The experiments of the past year were not decisive. Experience is necessary for the working out of the details of the experimental method, and the experiments are being continued.

Experiments on the fattening of sheep for the market have been made with the co-operation of Mr. Charles E. Lyman of Middlefield, one of the largest and most successful sheep-feeders in New England.

Digestion experiments with sheep have been continued. These are tests of the digestibility of different feeding stuffs, more especially those used in the feeding experiments with milch cows. Experience has shown that sheep digest nearly the same proportions of these materials as cows, and as experiments are more easily made with sheep they are used for the purpose.

THE FOOD AND NUTRITION OF MAN.

The Act of Congress providing appropriations for experiment stations in the different States makes provision for the study of the economy of the food and the laws of the nutrition of man. Congress also provides a special appropriation of \$15,000 per annum for inquiries in these directions. The responsibility of their execution rests in the Secretary of Agriculture, who has appointed the director of this Station as special agent of the Department of Agriculture in charge of nutrition investigations. The Legislature of Connecticut makes an appropriation of \$1,800 per annum for studies of food economy, and of the bacteriology of milk. The investigations by the Station on the food and nutrition of man are accordingly carried out in co-operation with the United States Department of Agriculture, and thus form a part of an extended system of inquiries, which are under the immediate supervision of the director, and have been and are being prosecuted in experiment stations, colleges, universities, and in co-operation with benevolent organizations in Maine, Massachusetts, New York, New Jersey, Pennsylvania, Virginia, Tennessee, Alabama, Missouri, Indiana, Illinois, Minnesota, North Dakota, California, and New Mexico.

The topics that have received especial attention are the composition of food materials, the kinds and amounts of food consumed by individuals, families, boarding-houses and institutions, the digestibility of food materials, and the fundamental laws of nutrition. The most important work of the Station is found in the experiments with man in the respiration calorimeter. Arrangements are being made for similar experiments with domestic animals. The object of these experiments is to gain more definite knowledge than we now have

of the action of the fundamental laws of the conservation of matter and the conservation of energy in the living organism. The research is abstract, time-consuming, and costly, but the results already obtained are highly encouraging. It is my belief that no work which the Station has attempted is producing or will produce results so valuable, whether viewed from the standpoint of pure science, or that of practical utility, as those of this class.

ANALYSES OF FOODS, FEEDING STUFFS, ETC.

In connection with the experimental inquiries above named, a large number of chemical analyses are required. These include analyses of the crops grown in the fertilizer tests, of the feeding stuffs used in feeding experiments with cows and sheep, of the foods used in experiments with man, and of the excretory products in the experiments with animals and man. In addition to the regular analytical work, inquiries have been made leading toward the improvement of the present methods of analysis.

METEOROLOGICAL OBSERVATIONS.

The usual observations of temperature, barometric pressure, wind velocity, humidity and precipitation have been made at Storrs. In addition, records of rainfall during the growing season have been made in other places in the State by farmers who have co-operated with the Station.

W. O. ATWATER, *Director.*

THE PRESENT ATTITUDE OF EUROPEAN SCIENCE
TOWARD TUBERCULOSIS IN CATTLE.

BY H. W. CONN.

When the subject of tuberculosis was before the Connecticut Legislature two years ago, it was urged by representatives of the Storrs Experiment Station that more information as to the actual condition of facts was needed. The Legislature did not see fit to make any appropriation toward obtaining such information. The Station was thoroughly convinced of its necessity, however, and during the last year, partly through aid from the Experiment Station and partly through the generosity of Wesleyan University, I have been enabled to visit many of the chief centers in Europe, where the matter of bovine tuberculosis has been a subject of special investigation. The opportunity has been used as far as possible to obtain information as to the attitude of European scientists toward problems which concern tuberculosis among cattle, as well as to inquire into the lines of experimenting which are now going on. The present paper is designed to put into the hands of Connecticut farmers the most recent information to be had upon this important subject. While the statements given apply primarily to the problem as it exists in Europe, they interest our own communities as well.

In such a discussion it is not always easy to distinguish fact from theory. It is, however, the failure to distinguish demonstrated fact from mere inferences that has given rise to much of the confusion and disagreement among those who have discussed this subject. It will be my endeavor, therefore, in this paper to make no statements as definite unless they are so well attested by facts that they may be regarded as parts of scientific demonstrations. Where opinions differ in regard to important points, the differences of opinion will be noted. Of course it is sometimes a matter of personal opinion as to whether any particular conclusion is demonstrated or still hypothetical, but it will be my aim, so far as possible, to make as definite statements only such conclusions as are acknowledged among scientific men as being proved.

The agitation over the tuberculosis question is upon a rather different footing in Europe from what it is in the United States. In this country the agitation very largely interests the people. In Europe the interest is thus far chiefly confined to the scientist. Our agricultural communities are, as a rule, better informed upon matters relating to agriculture than those of Europe. The large amount of scientific literature which is being put into the hands of our farmers by our agricultural journals and government publications make our farmers much better informed than the farmers of European countries. Hence it is that while in this country the farmer feels that he is especially interested in the tuberculosis problem, and that this is a subject that he must help settle, the farmer in Europe, as a rule, takes less interest in the matter, and looks upon it as something that the government must settle for him. The European scientists, therefore, who have studied into the matter are, as a rule, more interested in it than our own, while the public at large knows and cares less of the matter. Scientific men are leaders in legislation in Europe to a greater extent than they are in the United States, and, as a result, less mistakes have been made in legislation in Europe than in this country.

The subject before us will be considered under three heads: I. The present condition of tuberculosis among cattle. II. The battle waged against tuberculosis on the part of the agriculturist. III. Practical conclusions.

I. THE PRESENT CONDITION OF TUBERCULOSIS AMONG CATTLE.

A. CAUSE.

The cause of tuberculosis is to-day very well known, and so widely distributed is the knowledge with regard to it that little need be said upon the subject. The *tuberculosis bacillus* was discovered about fifteen years ago by Prof. Koch, and all of the investigations that have been carried on since that time have only served to confirm the conclusion that tuberculosis is in all cases produced by this particular bacillus. This tuberculosis bacillus is a small plant, which has the power to live as a parasite in the bodies of a number of mammals. If it finds entrance into the body it can feed itself upon the tissues of the animal, it can grow and multiply and continue to live under these conditions for a long time. As a result of its growth it produces certain chemical bodies which are very

poisonous and are probably identical with *tuberculin*. These poisons directly affect the tissues of the animals within which the bacillus is growing, causing various pathological growths which characterize the disease. The tubercles so characteristic of this disease are simply pathological growths in the animal, stimulated by the poisons excreted by this little micro-organism. The tubercle bacillus is capable of living as a parasite in quite a large number of warm-blooded animals. Those with which we are the most interested are, of course, man and cattle, but in addition to these we find that the bacillus can live as a parasite in horses, birds, rats and mice, pigs, goats, sheep, cats, dogs, and, indeed, other animals. The last four take it rarely. The only ones with which the agriculturist is especially interested are cattle and swine. The presence of the bacillus in other animals is too rare to make it a factor of any importance in agriculture.

The question whether the bacillus which produces the disease in man is identical with that found in cattle has always been one of very great interest and manifestly of very great importance. Upon the affirmative settlement of this question rests the possibility of the transference of the disease from animals to man and from man to animals. It has been very generally believed by scientists from the very first that the species of bacillus found in man and cattle are the same. There appears to be no difference in the bacillus as found in these two animals, when it is studied with the best microscopical apparatus. It has been shown by demonstration that the tuberculous material from man may produce the tuberculosis disease in cattle, and there have been many instances that point to the conclusion that the disease has been transmitted from cattle to man. If the disease can thus be carried from one to the other, there can be no question that the bacillus is the same in both animals. But there are still some facts which forbid us to give a positive answer to the question, and there is as yet no absolutely uniform opinion upon the subject. It has been learned as the result of recent experiments that, although there may be but one species of tubercle bacilli, there are a number of varieties more or less distinct and of different virulence. Some of these varieties appear to have a very much more decided power of producing the disease than others. Some of them inoculated into an animal will produce a virulent case of the disease, while other varieties under similar circumstances produce only a mild type. Recognizing, then,

that there do exist varieties of the tubercle bacillus, the question as to the identity of the bovine and human germs assumes a new aspect. May it not be that while the species is the same in both cases, the variety which is found in the one animal is slightly different from that found in the other, so that a type which produces a violent case of tuberculosis among animals might be one which would have very little effect upon man, and *vice versa*? It is manifest that this question will very materially affect the whole problem of the transference of the disease from man to animals. This question we will refer to again, later.

B. PREVALENCE OF TUBERCULOSIS AMONG CATTLE.

When the attempt is made to determine the prevalence of tuberculosis among cattle we meet with the very greatest difficulty. Nothing would seem to be easier at first thought than to determine to what extent our herds are infested with a disease so well known as this, but the more the attempt is made to obtain statistics, the more do we learn our ignorance upon the matter. The statistics vary so widely, and those taken at one place are so incomparable with those taken from another locality, that the whole question of the prevalence of tuberculosis is one with regard to which there is a vast amount of uncertainty.

There are two methods by which the prevalence of tuberculosis among cattle can be determined. The first is by the examination of animals slaughtered in slaughter-houses, and this is the only one which has been complete enough to give any definite conclusion. In several countries, official inspectors examine the animals slaughtered in slaughter-houses and make reports as to those in which evidence of tuberculosis is found, and these reports, as they accumulate year after year, should in time give a tolerable notion as to the amount of tuberculosis. But even this simple method of determining is subject to the widest amount of individual variations which are not connected with the actual amount of the disease. The results are influenced firstly by the skill of the inspector who makes the observations. An inspector with little experience may make many mistakes in diagnosing tuberculosis, and his results will be unreliable. The results are affected secondly by the care with which the inspection is made. Frequently the tuberculosis in a slaughtered animal may be developed to such

a slight extent that only a very minute lymphatic gland may be infested with the disease. In some cases a swollen gland no larger than a pea, and sometimes even smaller, will be the only evidence of the presence of tuberculosis. Now, in such cases it is, of course, very evident that an inspector who has many hundreds of animals to examine in a day and does his work somewhat hurriedly will overlook many instances of such incipient tuberculosis, while a second inspector, who has more time and a smaller amount of work to do, will discover them. The care that is given to the inspection, then, will affect the statistics very materially, and the figures that come from one slaughter house may therefore be absolutely incommensurate with those that come from the second. The results are affected, thirdly, by the personal inclination of the inspector, a factor that always enters largely into the statistics. One inspector desires to prove the wide prevalence of the disease and examines the carcasses much more carefully than the second, who is either indifferent, or desirous to reach the conclusion that tuberculosis is not very prevalent. The former will hunt carefully for all cases where even a small gland may be infested; the latter will overlook them. The result is that it is almost impossible to compare the statistics given at one slaughter house with those obtained at a second.

A second series of facts that very much influences these statistics is connected with the age of cattle that are brought to the slaughter-house. It is a well demonstrated fact that in Europe old cows are very commonly tuberculous, some veterinarians going so far as to say practically *always* affected with tuberculosis, while young animals are much more rarely affected. Now, if one slaughter-house chances to have only old cows brought to it for slaughter, while a second is concerned chiefly with younger animals, the statistics obtained by the one will be radically different from the other's, and inasmuch as no record will be commonly made of the age of the animals slaughtered, the statistics will give very erroneous conclusions. For these reasons, then, we see that statistics, even derived from such a clear method as examinations of carcasses, must be looked upon with suspicion.

A second method of determining the presence of tuberculosis is by the use of tuberculin. As is well known by every farmer, the inoculation of an animal with tuberculin will detect very accurately the presence of this disease, and will show its presence in living animals in many cases where clinical symp-

toms are absent. As would be expected, the amount of tuberculosis detected by this means is in excess of that indicated by the slaughter-house records. Tuberculin, as we shall see presently, detects incipient cases, and many a case that would be entirely overlooked by the most careful inspector of flesh. Moreover, it must be remembered that in no country has there been anything like a general inoculation of the animals from which could be obtained average results. Only such herds are generally tested with tuberculin as are somewhat suspicious. The results obtained from such a herd would be largely in excess of those which would be obtained if tuberculin were used upon all animals indiscriminately.

Considering, then, the uncertainty of the methods of getting statistics, it is not surprising to find that the conclusions as to the prevalence of tuberculosis among cattle are at wide variance with each other. The estimates run all the way from zero in some herds to one hundred per cent. in others, and the attempt to draw any average from such widely varying results is extremely fallacious and misleading. Nevertheless, taking together all of the facts derived from all sources, it is possible at all events to get some idea as to the relative amount of tuberculosis in different places and under different conditions.

It is found that the amount of tuberculosis among cattle varies with the climate. In the southern countries of Europe, like Italy, Spain, Switzerland, the amount of tuberculosis among cattle appears to be comparatively small, although this may be partly because it is less studied. The same is true on the whole continent of Africa, and to a considerable extent, also, with the cattle in the western plains of the United States. On the other hand, the amount of tuberculosis among the northern countries of Europe, Germany, Denmark, Belgium, Great Britain, is relatively large. Statistics are apparently showing to-day that the amount among our own herds in the eastern section of the United States is also large, possibly approaching in its extent that of some of the countries in Europe.

The variation in the amount of tuberculosis is to a certain extent parallel with the amount of outdoor life of the animals. In the southern countries of Europe, in Africa, and in our western territories, the animals are kept largely out of doors, and so long as they do not go into the stall and remain housed they are only slightly liable to this disease. In the countries, however, where the animals are kept indoors a large propor-

tion of the time, bovine tuberculosis is much more prevalent, and the amount of tuberculosis is roughly parallel to the extent of indoor life. Where the cattle are kept housed all the time, the amount of the disease is very large. There are two or three factors which probably explain this fact. In the first place, animals living indoors do not have as much air, and the activity of their lungs is impaired thereby. They are therefore more subject to an attack of the disease than animals living outdoors, where air has more easy access to the lungs and where vigorous exercise in the open fields keeps the lungs in a more active condition. Secondly, a very prominent factor is, doubtless, the fact that the tubercle bacillus has a very much more easy chance of access to animals in the stall than out of doors. Inside of the barn the cattle come in close contact with each other, and there is every possible means by which the germ can pass from one animal to the other. Out of doors there is not this close contact. Thirdly, it is a well known fact that the sunlight quickly destroys tubercle bacillus together with all other bacteria, and, therefore, if the animals live in the fields the tuberculosis bacilli which are excreted from them in any way are very rapidly killed by the rays of sunlight, so that after a comparatively few hours they are harmless. In the dark stable, however, they may remain alive and active for months. These three factors together very largely explain the greater prevalence of the disease in housed animals. It must not, however, be understood that tuberculosis is absent from animals that live out in the fields. It occurs occasionally in animals who never enter the barn, but the amount of disease among animals living in the free air is very decidedly less than in those living indoors.

We find, furthermore, that the amount of tuberculosis varies with the breed of the animal. There is no general agreement as to what breeds of animals suffer most. Some claim that Jerseys, Shorthorns, and Ayrshires are especially susceptible, but it is doubtful whether this is true. In general, the animals of high pedigree stock are more subject to the disease than ordinary cattle. The reason for this is probably not especially connected with the breed, but rather with the conditions under which they are kept. These valuable animals are usually great milkers, and their general vitality is somewhat lowered by the strain upon the animal to produce milk. This lowering of the vitality by a great production of milk renders the animal somewhat more liable to attack than

is the animal that is not thus weakened. It is probable, also, that other factors connected with the care of high bred stock, their being more generally housed, being kept warmer, tend to weaken the vitality of the animal so that the greater prevalence of tuberculosis in high bred stock is probably explained by conditions surrounding such stock rather than by anything peculiar in breed itself.

It is found, further, that the amount of tuberculosis varies with the sex of the individual. Apparently, female cattle are somewhat more liable to the disease than are male cattle. The difference, however, is quite slight.

It is found that the amount of tuberculosis varies with the size of the herd which any individual farmer produces. This is a significant fact, and at first somewhat surprising. If a farmer has a large herd of animals, one or two hundred or more, it is very likely to be infested, while the smaller herd of his neighbor may be free from it. Large herds show, also, a considerably greater per cent. of the disease than small herds. It is not difficult to understand that this should be so. An owner of a large herd is constantly buying new animals and thus increasing the chance of infection. In large herds, too, the chances of contamination of one animal by another are decidedly greater than in small herds. If a farmer keeps only a few animals he is less likely to buy infected creatures, and hence the chance of infection is greatly reduced. At all events this is found to be almost universally the case. Tuberculosis is more prevalent among large herds.

Taking all these things together, it is evident that any estimates as to the amount of tuberculosis present in our herds is almost valueless. And yet the figures that are given may be, at all events, interesting, and will certainly serve to indicate a prevalence of tuberculosis rather greater than has been generally believed. Taking the statistics which are derived from slaughter houses as the most reliable, we find that apparently the amount of tuberculosis among the herds in Europe varies from a minimum which cannot be given to as high as over fifty per cent. in all animals over one year of age. In the city of Leipzig, where the best records are kept, the amount is about thirty-three per cent. It must, of course, be understood, in speaking of these figures, that in these cases we have actual tuberculosis as discovered by post mortem examination. We must remember, too, that advanced cases of tuberculosis do not reach the slaughter-house, the owner knowing that the

bodies would not pass inspection. We must remember, lastly, that many a case of tuberculosis, if it be a very slight one, will escape observation entirely. Remembering these facts, and considering that the slaughter-house records give us a prevalence of tuberculosis sometimes as high as fifty per cent., or more, it is thoroughly demonstrated that the amount of tuberculosis among cattle in Europe is really very great. In the most recently reported statistics from the slaughter houses in Kiel, a city of North Germany, it is stated that sixty-six per cent. of the cows imported from Denmark have been found to be tuberculous. It is probably impossible to give any statistics of American cattle that would be comparable to these, chiefly because we have no complete slaughter-house records. Animals are slaughtered in the United States in so many private slaughter-houses, and official inspection is such a rarity, that we have no slaughter-house statistics that can be compared with these in Europe.

If we take the results of tuberculin inoculation we shall find that they are decidedly higher than those derived from slaughter-houses. In some of the northern countries the conclusion has been reached by those who have most studied the matter that the amount of tuberculosis is over fifty per cent. of all the animals in the land. Many small herds, especially those which have been all bred on one farm without purchase, will be entirely free. Larger herds, on the other hand, will have seventy and eighty per cent., and many large farms can be found without a single sound animal. But, taken altogether, it is admitted without any dispute that the amount of the disease in some northern countries is very nearly fifty per cent. This means, of course, that about one-half of the animals are afflicted with tuberculosis.

In general, then, as to the prevalence of tuberculosis, we may say that it varies very widely, running from zero up as high as fifty per cent. In some countries it may be small, but in none of the thickly-settled countries is the presence much less than ten per cent., and in most of them very much greater than this.

C. THE INCREASE OF THE DISEASE AMONG CATTLE.

A very vital question connected with the whole subject is whether tuberculosis among our cattle is on the increase at the present time. There is undoubtedly a very widespread

belief that such is the case. Certain it is that the statistics as they are being collected in the last few years are tending to show that tuberculosis is not only on the increase, but on the very rapid increase. The amount of tuberculosis as it is determined by the sources of evidence already pointed out is becoming larger and larger each year.

It is, however, difficult, if not impossible, to answer positively the question as to what rate tuberculosis is increasing. The uncertainty of the sources of evidence which have just been pointed out apply with equal or even greater force when we attempt to answer this question. To such an extent is this true that statistical evidence upon this question is of very little value and, indeed, almost worthless. Of course it is evident at the outset that no facts derived from the tuberculin test can give us any idea of the increase of the disease, inasmuch as this test is so new that it is only just beginning to be used, and, since the tuberculin test will discover many cases that have hitherto entirely escaped observation, the data derived from this source give no means of comparison with the past.

It might be supposed, however, that the data derived from slaughter-house statistics would be more significant, because inspection of the carcasses of slaughtered animals has been taken in some countries for many years. If these statistics are compared with those of earlier years, the results are to show a surprising and startling increase in the disease. Twenty-five years ago the amount of tuberculosis reported from such inspection was only three to five per cent. To-day it is ten to fifty per cent., and more often approaching the higher than the lower figures. This increase of eight to ten fold in the course of twenty-five years is, of course, very suggestive, at all events. But even here we must recognize that the value of these figures is extremely questionable. We know perfectly well that at the present time our veterinarians are making the inspection with a great deal more care than in earlier years. They have learned to recognize incipient cases of the disease more readily. They note at the present time cases where a single swollen tuberculous gland is found, and in earlier years such instances would never have been noted at all. The great interest that has been attached to the disease has, in short, made the inspectors of cattle so much alert in discovering its presence in carcasses that it is doubtful whether the figures obtained to-day can be compared at all with those obtained twenty-five years ago under conditions in which the veterinarians' atten-

tion was only incidentally turned to tuberculosis. It may, however, be worth while, at all events, to give a few figures illustrating these statistics.

Amount of tuberculosis as shown by slaughter-house records:

Bavaria.	Berlin.	Saxony.	Leipzig.
1877....1.62%	1883....2.86%	1888....4.90%	1888....11.1%
1888....2.7%	1885....2.10%	1890....15.7%	1889 ...14.9%
1895....5.%	1895....15.45%	1895....27.48%	1890....22.3%
			1891....26.7%
			1895....33.3%

The figures here given show certainly an extraordinary increase, and the last three years shows that the figures are still growing larger. Because of the reasons mentioned, statistics from slaughter-houses are only of value when they come from the same place and have been continued in the same locality for a period of years. It is probably impossible to compare with any accuracy figures taken from different localities and, moreover, even in the same locality, the figures are not comparable year after year unless the same inspector has been engaged in the duty of inspection. The personal equation is so great, the desire of some inspectors to find every case of the disease, and of others to find as few as possible, so interferes with the value of the statistics that the comparison of different localities and of different years in the same locality is open to very serious question. The figures given above for Leipzig are the most valuable, since they have extended over many years under the same management. The results in successive years are, therefore, probably more properly to be compared with each other than in most cases. But even here the personal factor and the increased attention must enter into the statistics. But the increase from 11.1 per cent. to 33.3 per cent. in seven years is startling. It is impossible to believe that these uniform results can be explained except by an actual increase in the amount of the disease. After allowing all weight to the personal equation we cannot avoid the conclusion that the statistics which are obtained from slaughter-houses and the absolutely uniform increase in the percentage of tuberculosis, as given by official reports, as well as the large amount of tuberculosis that is found yearly as the tuberculin test is extended, tell only too clearly that tuberculosis is on the increase in Europe. Most scientists are inclined to think that it is not only increasing, but increasing very rapidly. Certain

it is that the figures which have been shown above, if they indicate anything, indicate that the increase in the disease is not a slow one, and, while we recognize the uncertainty of the statistics, we must admit that this disease is beyond much question increasing in European herds with considerable rapidity.

In the United States there are practically no data from which any inferences can be drawn. The use of tuberculin is too new and has not been extended sufficiently to give any conclusions from this source, and official inspection of slaughtered animals has not been carried to an extent in this country to make it possible to draw any conclusions as to the increase of the disease here. There is probably little doubt that its course is the same as in foreign countries, and there is a general belief that it is increasing, but the question cannot be answered positively.

D. MEANS OF DISTRIBUTION OF TUBERCULOSIS.

Of all the topics connected with the subject of tuberculosis among animals and man, there is none of more importance from every standpoint than that of the method by which it is distributed from individual to individual. If we could learn this accurately we should be far along toward the solution of the problem of the weeding out of the disease, both among cattle and in the human race. It is a subject over which there has been a very large amount of study and thought and, as we shall see, a subject over which at the present time there is a very wide difference of opinion. Certain methods of distribution are well known and generally accepted, but upon nearly every point in connection with the subject there is some difference of opinion. In our consideration of this subject we will divide it into three heads, as follows: (a) Transmission from animal to animal. (b) Transmission from man to animal. (c) Transmission from animal to man.

(a) TRANSMISSION OF TUBERCULOSIS FROM ANIMAL TO ANIMAL.

The first point to demand attention in this connection is the question as to whether the disease is congenital, that is, whether it is carried from the parent to the offspring. While there has been in the past a great deal of dispute upon this matter, and while opinion has been greatly changed in the last fifteen years, it may be stated that finally there has been reached an absolute consensus of opinion. There is no longer

a doubt that the transmission of tuberculosis from the animal to the offspring, while it is of rare occurrence, occasionally does occur. This has been proved in the case of cattle by the discovery, in the first place, of the disease in new-born calves, and, secondly, by the discovery of the disease even in the embryo calf before birth. It is of course easy to understand how the tuberculosis germs which are present in the mother may find entrance through the uterus into the embryo before birth, and if so, congenital tuberculosis is certainly a possibility. The discovery of the disease well advanced in new-born animals and the discovery of well attested cases of the disease in the embryo settles the matter beyond question, so that one can no longer doubt that the disease may be congenital.

But, while this is true, the cases of congenital tuberculosis are so rare that they may be almost neglected in consideration of methods for preventing the distribution of the disease. The vast majority of calves born from tuberculous mothers are healthy and show no signs of the disease at birth. Whether they are more subject to subsequent infection than are the calves of healthy animals is still, perhaps, uncertain. It is a general belief that in the human race the children of tuberculous parents are more likely to take the disease than children of other parents. This is at all events a possibility, and perhaps we may say a probability, among animals as well as man. The fact that an animal has yielded to the disease would indicate that it has less resisting power than another animal that has not thus succumbed. It would be natural to suppose that this resisting power, being a result of the general vitality of the animal, might be transmitted to the offspring. Hence it would follow that offspring from tuberculous animals would be more likely to yield to the infection than the offspring of non-tuberculous cattle. But this is not yet demonstrated.

Tuberculosis is now well known to be a contagious disease, and that it in some way passes from individual to individual is beyond doubt. That it extends through a herd of cattle from one infected individual to others appears also to be well attested by many instances. Nearly every farmer will recall cases where the introduction of a single tuberculous animal into a herd has been the cause of the spread of the disease through the herd until a considerable portion of the animals have been infected. It is certainly a general belief among practical agriculturists, and among scientists as well, that this

is the common means of distribution through our herds of cattle. In previous years there was no tuberculosis among cattle in Japan, but a few years ago it was brought to the country by certain imported animals, and has subsequently extended quite widely, largely, it is true, among the imported cattle. In Denmark it was first introduced by cattle from Schleswig, and has since spread widely. It is a belief, also, that the same was the history in the United States, that the tuberculosis in our cattle is to be traced to the importation of certain animals from the Old World who had the disease.

When the question is raised as to exactly how the disease is carried from one animal to another, the answer is not so easily given. The disease can only be transmitted from one individual to the second when the tubercle bacillus itself finds an exit from the diseased animal and finds some entrance into the body of a healthy animal. The common channels of entrance are the mouth and nose, although it also may gain access to the body through the sexual organs, through the mammary glands, and through wounds. The last three methods of infection are of comparatively little importance. To pass from one animal to another the bacilli must of course first find an exit from the infected animal. The most common location of the disease among cattle is in the lungs, although it is present also in a very large amount in the other organs. Cattle, however, do not void sputum from the mouth, and thus sputum, which is regarded as the most common means of the distribution among man, can play little or no part in the distribution among cattle. It is true that the bacilli as they come from the lungs may pass up into the mouth and the nose of the animals, and when there are slight discharges from the nose and mouth, as is not uncommon, these may be means by which the germs are eliminated from the animal. It is quite easy to understand how a cow suffering from tuberculosis in the lungs may thus infect the water in the watering trough from which she drinks, by dipping her nose into the water, and thus allowing some of the germs which are in the nose or mouth to pass into the water. It is easy to understand, then, how a second animal, drinking from the same trough, may get the germs into her own mouth and stomach and thus become infected. While this is a possible method of distribution, we must recognize, however, that among cattle the discharges from the lungs do not, as a rule, pass from the mouth, but are swallowed, and consequently the bacilli will tend to pass into the stomach rather than to pass

out of the mouth. The bacilli that thus pass through the stomach may eventually serve for a secondary infection in the alimentary canal of the animal, or they may pass away in the excrement. The boots of the attendant will now distribute the excrement from stall to stall, and even infect with the bacilli the hay which the cows are to eat. Anyone familiar with the habits of the attendants of cattle will easily see how the disease may be thus distributed by the excrement of infected animals.

A second source of elimination of the bacilli from the lungs has recently been discovered and must not be neglected. It has been shown by recent experimental work that one of the common methods of the distribution of germs is in the small particles of vapor which pass into the air from the mouth or lungs of an individual when coughing. Ordinary breathing has for a long time been known to have no power to distribute bacilli, since they cling to the moistened surface of the mouth and throat; but the most recent experiments have shown that in the case of coughing, minute particles of water are discharged from the mucous membranes of the mouth and throat and are blown into the air, where they float around for a time in the form of an imperceptible mist. They may now be distributed for long distances by the currents of air, even in a closed place, like a cow stall. If the air thus becomes charged with the bacillus-laden drops of moisture, it is perfectly clear that healthy animals, even if some distance away, in the same apartment may breathe these particles of moisture into the lungs and thus obtain infection. The bacilli from all these sources will adhere to the rough surfaces of the cow-stall, and may necessitate frequent disinfection.

Another method by which the animal may convey the bacilli is by actual contact with other animals, especially if the animals bring their noses together or if they cough in each others faces. If they are eating out of the same mass of hay, one may infect the food with the bacilli from its mouth and the other individual swallowing the hay may thus become infected.

That the milk of a tuberculous animal may under certain conditions contain the bacilli is demonstrated beyond question. It is clear that the calves sucking milk from a tuberculous mother may from this source obtain the bacilli, which start an infection in their own bodies. If such milk is carried to a creamery and run through a separator, the skim-milk will contain many of the bacilli. Now, by the ordinary cus-

tom, the farmer who brings his milk to the creamery carries home a lot of skim-milk to feed to his calves and pigs. He never gets his own skim-milk, but that which is running through the separator at the time he is at the creamery. It is evident, therefore, that if there are any tuberculous cows furnishing milk to the creamery, their skim-milk will in time be distributed all over the territory patronizing the creamery. In this way, calves and pigs may acquire the disease. The slime which collects upon the drum of the separator is full of tubercle bacilli. This is frequently fed to pigs, and as a consequence in Northern European countries such swine become very rapidly infested with tuberculosis. The separating creamery becomes thus a prolific means of dissemination of the germs of tuberculosis. To avoid this danger, in some countries the skim-milk is pasteurized (*i. e.*, heated to 170°) before being given to the farmer, and the slime from the machine is burned.

There seems to be, then, little question that there are easily understood means by which the bacilli can pass from an infected animal to healthy animals. At the same time the facility of transmission is not so great as among men who void sputum. This lack of sputum has so impressed bacteriologists that there are some scientists of repute in Europe to-day who regard the transmission of the disease from animal to animal as of comparatively rare occurrence, and some go so far indeed as to claim that the transference of tuberculosis from animal to animal almost *never* occurs. They tell us that if tuberculosis is found in a herd and is distributed through the herd we must look for some other source of distribution than that from animal to animal. They claim that the chances are so slight of the distribution of the disease from one animal to another that this method may be almost neglected. Such a conclusion, although it is held at the present time by several rather prominent bacteriologists, is not, however, generally accepted; and the vast majority of scientists, bacteriologists, veterinarians, and agriculturists are united in regarding the transference of the disease from animal to animal as the chief method of its distribution among cattle.

(b) TRANSMISSION OF TUBERCULOSIS FROM MAN TO ANIMAL.

The question as to whether the disease passes from man to animal is one upon which there is the very widest difference of opinion. We have, as just noticed, on the one hand,

a certain number of bacteriologists who claim that this is the common method of the distribution of the disease, and some who even insist that this is practically the only method by which cattle obtain tuberculosis. These bacteriologists point to a number of very significant facts. In the first place, they emphasize the fact that cattle do not void sputum, while, on the other hand, they show the great likelihood that the disease may pass from man to the animal because of this habit of spitting. That the sputum of the consumptive patient contains the bacilli in large quantities has long been demonstrated, and when this is voided in the barn and becomes dry it may pass into the air and be breathed in by the animals, or, if it comes in contact with the hay or even with the floor in the vicinity of the cow stall, it may be taken into the animal with its food. The chance for such distribution is certainly very great, for attendants are certainly not particular in regard to spitting. These bacteriologists further point to significant facts in regard to the relation of the disease in animals and man. They show us that so long as calves come in contact only with their mothers the amount of tuberculosis is very small; that the amount of the disease, however, increases rapidly year after year, and that this increase in the disease is directly proportional to the contact with man. Calves apparently do not, as a rule, take the disease from the animals with which they are associated, but as they are year after year more and more closely associated with man, in milking and in the general care, the amount of tuberculosis increases. They tell, too, that the amount of the disease in a herd is largely proportional to the healthfulness of its attendants. In sanitary institutes, for instance, where the attendants of the cattle are presumably in considerable measure suffering from tuberculosis, the amount of tuberculosis among the cattle is always very great. We are told that there are practically no cases of healthful herds where they are attended by the patients of sanitary institutes. These bacteriologists tell us, further, that the condition of the herd may be always predicted from the condition of the family that has charge of the herd. If the inspector looks first at the people on the farm and finds one or two of them that appear to have traces of tuberculosis he can predict with absolute certainty that he will find the same disease among the cattle. These facts together have led to an assumption that the transference of the disease from man to animals is not only common, but it is the greatest source of the disease among animals.

There is at least one prominent bacteriologist in Europe who goes so far as to say that this is the one source of distribution, and that the disease practically never is found in cattle unless it comes from the attendants.

Such an extreme position is, however, held by very few. While no one will question the possibility that the disease may be carried from man to animal, it is yet impossible to point out any definite instance where the transference has been proved. This, of course, however, proves nothing in itself, because from the very nature of the case it would be impossible to find evidence for such transference, even if it occurred. But many other facts are indicated as showing that the transference from man to animals is not the common method. In the first place, tuberculosis among mankind has been known for many centuries. Apparently the disease among animals is new, or comparatively new, and if the disease is transmitted solely from man to animal we utterly fail to explain how it is that the disease has been apparently increasing so rapidly in recent years, when, as we know, the disease in mankind has been decreasing. This in itself is enough to indicate that there must be some means of distribution other than from man to animal. Moreover, as mentioned above, in Japan the disease was not known among domestic animals until recent years, and in Denmark it is said to have been introduced by imported cattle from Schleswig. Tuberculosis in mankind, however, has been known in these countries for a long time, but it was not until the disease was brought by some infected animals that it began to extend. If these facts are thoroughly attested, of course it follows that we cannot regard man as the chief or even the important source of the disease in animals.

Whether, then, the disease is transmitted from man to animals is at the present time not definitely settled. That it may be transmitted is certain. That it positively is thus transmitted is not as yet demonstrated. That it is the chief method of the distribution of the disease appears to be very doubtful.

In the most recent period there has been a line of investigation undertaken in our own country which apparently indicates that this source of distribution cannot be regarded as a serious one. A series of facts has led Prof. Smith of Harvard to investigate the question as to whether the variety of the tuberculosis bacillus in man and cattle is the same. The experiment consisted briefly in the following. Several examples of tubercle bacillus were obtained, part of them from human in-

dividuals and part of them from cattle. These were kept under identically the same conditions. A number of calves were inoculated with the bacilli from the different sources. The experiments have really only begun, but the result of the first series was very striking. It was found that the calves which were inoculated with the bacilli that had come from cattle became seriously infected with tuberculosis, which was rapidly diffused and developed to a very great extent. They became, in other words, severe cases of tuberculosis. It was found, on the other hand, that the animals that were inoculated with the bacilli which had come from human beings, while they did develop the disease, developed it only in a mild type. There were produced only slight local tubercles, which apparently soon ceased to develop, and the animals suffered practically nothing from them. In one case the disease extended rapidly and produced serious trouble; in the other case the disease was so slight as to become soon ended. These experiments seem to indicate that the variety of tubercle bacillus that is capable of producing the severe type of the disease in man is not capable of producing the severe type of the disease among animals. Of course, if this is a fact, and the facts must be tested by further experiment before they can be accepted as certainly true, it will follow that we cannot look upon human beings as an important means of distribution of the disease to the animals. While we may recognize such infection as a possibility and perhaps as occurring rarely, it certainly will follow from these facts that the chief sources by which the disease is distributed to the cattle are other than through their attendants.

(c) TRANSMISSION OF TUBERCULOSIS FROM ANIMAL TO MAN.

There is no subject connected with tuberculosis of more general interest than the question as to whether the disease is ever or commonly carried from the domestic cattle to mankind. The discovery of the identity of the disease in man and animals has raised this question, and, since the year 1884, when the tubercle bacillus was first discovered, the question as to the transference of the disease from animal to man has been prominently before the public mind, as well as a subject of scientific investigation. During the fifteen years that has elapsed, many modifications of the original opinions have arisen, and the attitude which the scientific world takes toward

this question to-day is quite different from that which it has been at certain periods in the last fifteen years. It is true that at the present time there is not an absolute consensus of opinion, but differences of opinion are, to a certain extent, disappearing, and at the present time it may be stated that we are approaching somewhat slowly toward a general consensus of belief upon the matter. The statements which will be given in the following paragraphs are as closely as possible in accordance with the general results and the general belief as they are held at the present time.

In the first place, we notice that there is as yet no evidence that the disease is carried from cattle to man by means of the germs which are coughed up from the lungs and exhaled adhering to particles of moisture, as already described, nor is there any evidence that man obtains the disease by breathing the dust which comes from cattle in any form. While we have no such direct evidence, this by no means indicates that such infection may not occur. From the very conditions of things, if such infection did occur it would be practically impossible to prove it, so that we must not regard this negative evidence as of much importance. If the disease is transmitted from animal to animal by the moisture of the breath there would seem to be an equally good chance for its being transported from animal to man.

Transmission by Flesh. Tuberculous Meat.—There has been a large amount of investigation in connection with the possibility and the probability of tuberculosis being carried from animal to man in the flesh of the animal used as food. A very large amount of experiment in this connection has been carried on in the last fifteen years. These experiments have in large degree consisted in the feeding tuberculous flesh to animals which are known to be subject to the disease, and then the noticing whether such consumption of tuberculous flesh produces tuberculosis in the animals thus fed. The result of these experiments has been conclusive enough. While it does not always happen that tuberculosis will follow the eating of tuberculous material by such animals, it has resulted in a sufficient number of cases to show beyond peradventure that this disease may be transmitted by the flesh of animal suffering from the disease.

In spite of these results the studies and investigations of the last few years have been very rapidly but very conclusively

leading to the belief that the danger of distribution of the disease by the flesh in our markets is extremely small, so slight, indeed, as almost to be neglected. In the first place, no actual cases of the disease being transmitted to man by flesh are known. This, however, may be due to the difficulty of getting evidence of such cases, even if they should occur. But the actual danger appears to be slight. A considerable majority of the slaughtered animals, even though suffering from the disease, have the infection localized only in a few glands. In the ordinary cases the infection is almost always either in the abdominal organs or in the lungs or in some of the lymphatic glands. It is only under very exceptional circumstances that the disease is found in the muscles. Now, if the organs of the thorax and the abdomen are removed after slaughter, all of the organs most ordinarily affected are separated, and the flesh which is sold and consumed for food will contain, in the vast majority of cases, no tuberculous lesion. No one holds that the presence of a small tuberculous gland in the abdomen can have any deleterious effect upon the flesh, and if properly slaughtered the flesh of such animals is wholesome. Such flesh may, it is true, become contaminated during the slaughtering and dressing by the use of unclean knives. It is said that the butcher in removing the visceral organs of the abdomen may cut through the tuberculous parts, his knife may thus become smeared with the tubercle bacilli, and in the subsequent cutting up of the animal the flesh itself may become similarly smeared. Of course, a remedy against such infection would be in a more careful use of the knives. But, even supposing the flesh to be thus contaminated, it is only infected upon its surface, and such contamination never affects the interior of the muscle mass. Now, it must be remembered that the flesh of animals is practically always cooked before it is eaten. It is well known that a moderate temperature, 170° (70° C.) for a few moments, will either completely destroy the tubercle bacilli or so lower their vitality that they are no longer injurious. Hence it follows that the cooking which the flesh receives will practically destroy all danger of the disease being transferred by means of it. It is true that in cooking of beef the interior of the mass frequently may not reach a temperature of 170° , but the surface is practically always thus heated, and this secondary contamination from butchers' knives, being wholly superficial, will be entirely remedied by the cooking. As the result of a long series of inquiries the almost universal

conclusion is reached that the flesh of a tuberculous animal under these circumstances offers no danger to mankind.

There are, however, conditions under which the flesh of the animal may be dangerous. In cases of what are known as generalized tuberculosis the bacilli appear to be scattered all through the tissues, or even in the blood, and in these cases they may be found in the masses of the muscles. No one questions that it is dangerous to eat such flesh unless it is thoroughly sterilized by boiling. But if the advanced cases of the disease are excluded by proper inspection, the universal opinion at the present time is that the flesh of tuberculous animals which comes from creatures with only slightly developed disease is perfectly wholesome, presents no danger, and that there is no reason whatsoever for excluding such flesh from our markets. The only problem is as to the feasibility of a proper inspection. In European countries that are under the best control the carcasses of animals slaughtered in the slaughter-houses are not all treated alike. Some are entirely condemned, this class including only such as have advanced cases of generalized tuberculosis. Others are partially condemned, that is, the viscera, or, perhaps only parts of the viscera are condemned, but the flesh is allowed to be used. In other cases, where the disease is perhaps somewhat more extended, the flesh is allowed to be sold in the markets, upon what is known as the "free bench," which simply means that it is sold to the customer as diseased flesh. The customer buys it at his own risk, and knows that he should not eat it unless after thorough cooking. The method which has been adopted somewhat widely in this country, of entirely condemning the carcasses of an animal that shows the slightest trace of tuberculosis, is adopted nowhere in Europe, and is regarded universally as a needless and useless waste.

In short, there are no cases positively known where mankind has acquired the disease by eating flesh, and all of the facts taken together have led to a unanimous opinion that the danger from the flesh of tuberculous animals has been exaggerated in the past, and that there is no reason why, under proper restrictions, the flesh of such animals should not be used for food.

Transmission by Dairy Products. Tuberculous Milk.—When we come to the subject of dairy products, the matter stands somewhat differently. The danger to man from the consumption of milk and products derived from milk is certainly greater than it is in the case of flesh. All of the evidence that

has been collected during the fifteen years' study has constantly pointed toward the existence of such a danger. The reasons which have led to the universal belief that milk may be a source of danger are essentially as follows: In the first place, as we have seen, it has been demonstrated clearly enough that under certain circumstances the tubercle bacilli are found in the milk of tuberculous animals. Exactly at what stage of the disease the milk may become contaminated with the bacilli has been not so easily settled. While a variety of opinions have been held in the past, the practically unanimous opinion at the present time is that the milk does not become contaminated with the bacilli unless either there is generalized tuberculosis, or the udder itself is the seat of the tuberculous infection. If there is a tubercle in the milk gland, then the milk becomes contaminated. Those who have believed that the milk may become infected, even in animals not suffering from udder disease, have probably either been dealing with cases of generalized tuberculosis in its advanced stages, and here it is also recognized that the milk may become infected, or they have probably had a case of udder disease so slightly advanced as to be not visible externally nor even with the post mortem examination usually given. If now the milk of tuberculous animals may thus contain the tubercle bacilli there appears to be no reason for doubting that the consumption of such milk may produce the disease. To this conclusion innumerable experiments have attested.

The experiments which have been devised for determining the infectiousness of milk have been quite varied. Most of them have consisted of inoculating the milk into the abdomen of susceptible animals, the guinea pig being the animal commonly used, simply because the guinea pig has shown itself to be very susceptible to the disease. Inoculations have been made in other animals, however, as well, such as pigs, rabbits, calves, and others. In other cases, however, the experiments have been made by *feeding* the milk to the animals in question, instead of inoculating them, on the manifest ground that abdominal inoculation is entirely different from consuming milk as food. These experiments have all given the same result, namely, that both the abdominal inoculation and the feeding of such milk to experimental animals is very likely, though not sure, to produce cases of disease. Hundreds and hundreds of positive results have been obtained where perfectly healthy animals, either being inoculated with or fed upon milk from

tuberculous animals, acquired, in the course of a few weeks, plain infection of tuberculosis, while other control animals under the same conditions and fed upon sterilized milk have failed to develop the disease.

The conclusion that milk is thus a possible source of infection is not confined simply to experimental evidence upon animals. Various facts in connection with the disease in man point in the same direction. Many cases have been instanced where persons have developed tuberculosis under circumstances which point strongly to milk as a source. One well known example of this sort may serve as illustration. A boarding school in the city of Paris had fourteen girls, nine of whom were in the course of a few months taken with tuberculosis. An investigation showed that they had all been using milk from one cow, and that that cow was markedly tuberculous. The inference was that the milk of the animal had given rise to the disease in the girls. This is only one instance of which many others are known. Of course it must be recognized that such instances are not proofs, for it is possible that there was some other source of infection than milk. In all similar instances of human beings deriving tuberculosis from milk there is always a little lacking to a complete demonstration. While the probabilities have always been that milk is the source of trouble, the matter is not accurately demonstrated, because of the impossibility of getting demonstrations in regard to so obscure a subject. There has been one recently reported instance which is somewhat closer to a demonstration. It is in the case of a man who had some tattooing performed on his arm and used milk for the purpose. After the tattooing there developed on the arm certain tuberculous swellings, which were plainly traced directly to the operation of tattooing. It was found that the animal from which the milk had been obtained was tuberculous, and the conclusion that this case of skin tuberculosis came from the milk is unquestionable.

It is not necessary to dwell upon this side of the question longer, because the possibility of danger from the consumption of milk is too thoroughly recognized to require extended discussion. It is the universal opinion in Europe and in this country, of those who have looked into the matter, that there is a danger to mankind in the use of tuberculous milk. The question, however, of more importance, and the one in regard to which there has been recently a change in public opinion, is as to the *extent* of this danger. It is possible that man obtains

tuberculosis from milk. Is this a common event, or is it one of extreme rarity? That the danger is greater than the danger from the use of meat is clear enough from the fact that meat is so universally cooked and milk, at least in some countries, so generally consumed without cooking. But this does not tell us that the danger is very great. After careful study of the problem for many years there appears to be at the present time, in the minds of the scientists, an undoubted tendency to regard the danger as very much less than has been supposed. Indeed, so true is this that many of those who have studied the matter carefully are inclined to think the danger is almost nothing, and while it is not to be neglected, it is a danger which is so slight that it does not deserve anything like the amount of attention that has been given to it. The reasons for this conclusion, which is, of course, a satisfactory one, both for the public in general and to the agricultural community, are in general as follows: First, as already indicated, the milk becomes contaminated only in the case of advanced tuberculosis, or in the case of localized udder disease. The cases of advanced tuberculosis will very rarely furnish any milk for the public milk supply, these animals being almost universally excluded from the milk-producing herd. The cases of udder tuberculosis are also rare. According to the best knowledge that we have, probably less than one per cent. of the animals suffering from the disease have tuberculosis in the milk gland. This, of course, reduces the chance of milk contamination very greatly. Furthermore, milk, as it reaches the consumer, under ordinary conditions, is mixed milk. That derived from one animal is mixed with that from many others, so that if there chances to be one or two animals suffering from udder tuberculosis their milk is almost sure to be mixed with a large amount of milk from healthy animals. Thus the number of bacilli in a sample of milk is greatly reduced.

Such facts, then, indicate that the contamination of the milk and its products is perhaps not very common. But how common? To this question we can give no answer. It has been found impractical to determine by microscopic tests whether milk contains the tubercle bacillus or not. There are methods by which it can be done, but they are at present unsatisfactory and wholly unreliable. The only even approximately satisfactory method of determining whether a given sample of milk is infected with the germs is by inoculating it into the abdomen of guinea pigs. If the milk does contain the

bacilli, even in small numbers, such inoculation is sure to be followed by the disease. This method, of course, is slow. It requires several weeks to obtain results, and it is therefore of no use as a practical method of testing milk. It is, however, a method capable of giving valuable scientific results as to the general infectiousness of milk. It is such experiments with guinea pigs which have led to the conclusion that milk from only such cows as are suffering from udder tuberculosis is dangerous. Similar experiments have been made to test the infectiousness of mixed market milk of cities, with the result of showing that market milk is frequently, though by no means universally, infected with the tuberculosis germs.

Such experiments with guinea pigs are, however, open to very serious criticism, and various considerations lead us to doubt as to their value in indicating a danger to man in consuming such milk. In the first place, it is very certain that the guinea pig is far more sensitive to tuberculosis than man. Indeed, the guinea pig appears to be more sensitive than any other animal yet discovered, and the fact that a guinea pig would succumb to tuberculosis if inoculated with milk, while it indicates that tuberculosis bacilli are in the milk, does not at all indicate that such milk would be dangerous to man. Secondly, most of these experiments upon guinea pigs have been performed by inoculating the milk or butter into the abdomen of the animal, and this is very properly pointed out as a very different thing from using the milk as food. The fact that sensitive guinea pigs will *frequently* succumb to tuberculosis if milk or butter is inoculated into their abdomen, while it does indicate that tubercle bacilli are *frequently* present in these dairy products, is far from indicating that such dairy products are likely to be of any danger to mankind when used as *food*. Some of the experiments with animals, indeed, have been performed by using the milk or butter as food, and these, of course, are more in accordance with the conditions in mankind. Under these circumstances a considerably smaller proportion of the animals suffer from the disease, a fact which indicates, of course, that there is less danger when the tuberculous milk is used as food than when inoculated into the abdomen.

A third series of facts has been recently discovered, which throws even greater doubt upon the whole series of experiments. It has been found that there is present in the milk a

species of bacillus which has considerable resemblance to the tubercle bacillus, but which is not the tubercle bacillus. When studied microscopically, this bacterium cannot be distinguished from the true tubercle bacillus, and if found in milk would undoubtedly be confused with it. Moreover, when inoculated into guinea pigs it produces a disease, and frequently death, with symptoms very similar to those of true tuberculosis. An examination of the body after the animal has died shows the presence of abnormal growths very similar to those produced in tuberculosis itself. Now, these bacilli are certainly quite common in milk and butter, and if butter or milk containing them is inoculated into guinea pigs the animals will die and show some symptoms of tuberculosis. The experiment would be undoubtedly set down as indicating the presence of the tubercle bacilli in the milk. But this bacillus is not harmful to other animals, and probably not to man. It is certainly not the cause of tuberculosis. Now, the studies of recent months have shown that many of the fatal results in the guinea pig experiments have been caused by these false tubercle bacilli, and not by the true *bacillus tuberculosis*. By further experimentation it is possible to distinguish between these two types of organisms. They grow differently and have different pathogenic powers. Now, recognizing the common presence of this false bacillus in milk and butter, it is plain that the previous experiments of inoculating guinea pigs are open to quite serious question. Some observers have gone so far as to claim that nearly all of the fatal results obtained from inoculating butter into guinea pigs have been due to this false bacillus, and not to the true bacillus. Even those who have been foremost in the inoculation experiments, and in claiming the seriousness of the problem, have acknowledged that many of the positive results have been due to this false bacillus, although they still claim that the true tubercle bacillus produces a certain proportion of the positive results in their experiments. This claim cannot be doubted.

From all these facts it is clear that the method of testing the infectiousness of milk by the use of guinea pigs is open to serious question. This is entirely too sensitive a method of testing, for the guinea pig will succumb to a disease, either tuberculosis or one of a similar nature, from the inoculation of products which would be entirely harmless to man, and in some cases from products which contain absolutely no true tubercle bacilli at all. While, therefore, the inoculation experiments

that have been going on for several years now have indicated that butter in quite a large percentage of the specimens, thirty to forty per cent., contains active bacilli fatal to guinea pigs, and that market milk in considerable proportion also contains them, we must admit that the conclusions thus drawn have little or no relation to the problem of human health, and that they do not indicate of necessity a danger from the milk at all proportional to the seeming results. The general consensus of opinion at the present time appears to be that the danger from the use of milk, as indicated by inoculation experiments, has been certainly very much overdrawn.

To these facts must be added the evidence given elsewhere pointing to the existence of varieties of the tubercle bacillus. If the human bacillus is only slightly pathogenic for cattle, it is at least likely that the bovine variety may not be very dangerous to man, although this remains to be proved.

The same facts arise when we come to study the conditions of tuberculosis in mankind from a statistical standpoint. It must be remembered that the use of dairy products has been quite rapidly increasing in the last fifty years. This is particularly true of England and the United States, and it is true also to a certain extent of other countries. We have seen above, also, that there are very good reasons for believing that the amount of tuberculosis among our cattle is increasing, and increasing somewhat rapidly. If, now, it were a fact that mankind obtained this disease to any appreciable extent from milk, we should expect to find the amount of tuberculosis in mankind increasing, and especially in those countries where there is the largest increase in the use of dairy products. Furthermore, it is a fact that in most European countries milk is not drunk raw to any very appreciable extent. Nearly all of continental Europe has, in the last few years, acquired the habit of sterilizing the milk before using it. In some countries this is almost universal. In Switzerland the children are taught the danger of drinking milk without sterilizing, and at the present time the amount of milk drunk without some kind of preliminary heating is comparatively small in continental countries. On the other hand, in England and in the United States the habit of sterilizing milk has not obtained much foothold: While milk is sterilized frequently for use among infants and invalids, there is no such general custom as in Europe in this direction, and in these countries we may say that the great bulk of the milk is drunk without sterilization. Now if milk were a con-

siderable source of tuberculosis, it would be inevitable that we should find a difference in the statistical results from countries where milk is used raw, and those from countries where it is sterilized.

Now, what are the facts as shown by statistics? In the first place, during the last forty or fifty years there has nowhere been an increase in tuberculosis among men, but a very decided decrease. In Great Britain the decrease in forty-five years has been thirty-nine per cent. In America, in the United States, there has been a decrease of about the same amount. In the continental countries, so far as statistics are comparable, the results are the same. Everywhere among European countries the last half century has seen a very marked decrease in the amount of tuberculosis. Now, this decrease in tuberculosis includes the disease at all ages, among adults and among children. It includes a decrease in all kinds of tuberculosis, the tuberculosis in the lungs as well as in the organs of the abdomen. It is true that the decrease among children has not been so great as it has been among adults, and it is claimed by some that tuberculosis of the abdominal viscera among children has not decreased. Moreover, the decrease in tuberculosis is as great, or perhaps greater, in England and the United States where milk is consumed without sterilization as it is in continental Europe where the milk is practically always sterilized. And, lastly, there is apparently no greater decrease on the Continent in the last few years, since the introduction of sterilization of milk, than in other countries where sterilization has not been so widely adopted. The decrease in tuberculosis has been a constant one, but has been especially rapid since the discovery of the tubercle bacillus. This decrease is attributable to greater knowledge of the disease and to better sanitary conditions. It is found, further, that the amount of tuberculosis is the greatest among poor children, and this is simply connected with the poorer nutrition. The country of Japan apparently has a larger amount of tuberculosis than almost any other country, it being stated that nearly one-third of the deaths occur from this disease. But the tuberculosis in Japan is certainly not traceable to milk, because until within very recent years the Japanese have not used milk as food. Within the last ten years the use of milk has become somewhat common in Japan; previously its use has been almost unknown. Nevertheless, the amount of tuberculosis has been and still continues at this very high per cent.

Taking all of these facts together it is certainly plain that dairy products cannot be regarded as a very prolific source of tuberculosis, and that this danger is far overshadowed by other sources and is practically confined to children. While at the present time there is a considerable variation in the opinions of different bacteriologists upon the question, there is a very manifest tendency toward a minimization of the danger. The general opinion would be somewhat as follows. Milk from tuberculous animals may be infected with the bacilli, if the animal has udder tuberculosis or generalized tuberculosis. Such milk may be dangerous to mankind. The danger, however, is confined practically to young children, adults, except in rare instances, not being amenable to tuberculosis from this source. The fact, however, that the milk of most tuberculous animals contains no bacilli, that the milk is commonly mixed with other healthful milk before it is drunk, that it is taken into the stomach and acted upon by the digestive juices, and that man, especially if in health, has a considerable personal resistance against an attack of the disease, reduces the danger from this source very greatly. Furthermore, when we consider the very decided reduction in the amount of tuberculosis in the last half century, running parallel with the increase in milk consumption, and the increase in tuberculosis among cattle, we are driven unquestionably to the conclusion that if milk is a source of danger it is one of the small sources of danger, that the vast majority of cases of tuberculosis in man come from other sources than milk. We must regard the danger as existing especially for children, but its extent does not appear to be very great.

II. MEASURES FOR COMBATING TUBERCULOSIS.

We now come to the question, very important for agriculturists, as to what kind of a battle can be waged against this disease. It is a distinctly agricultural problem, only indirectly concerning the public. At the outset we may ask whether there is a probability that the disease can be eradicated from our herds. It is well known that pleuro-pneumonia has been practically exterminated from cattle. It has been claimed that we may have equal success in eradicating tuberculosis and in time obtain a set of cattle entirely free from the disease. There are, however, few people, probably no scientists, who have such a hope at the present time. The problem is a very

different one from that presented by pleuro-pneumonia. The disease is so widespread that it is manifestly impossible to expect the slaughter of every animal suffering from the disease in an incipient form. It would mean bankruptcy to agriculture. Moreover, if it is true, as most bacteriologists believe, that the disease can be communicated from man to the animal, it is very certain that there will be a continued source of new cases until the disease is also eradicated from mankind. Considering these difficulties, it is plain that we cannot hope to deal with the subject as we have dealt with pleuro-pneumonia. What may be hoped, however, is that the disease may be reduced in amount and kept down to manageable limits.

In the first place, it is evident that the problem is for our agriculturists a very serious one, a more serious one, indeed, than our American farmers are inclined to believe. It is certainly unwise for our agricultural communities to attempt to shut their eyes to the facts as they exist. It is equally unwise to overdraw the facts and produce undue alarm, either on the part of the farmers or on the part of the general public. The facts as they exist, however, indicate that the problem is a grave one, and that it concerns the agriculturist himself more than it does the general public. It is true that the general consumer is interested in not having tuberculosis brought to him in his meat or milk or butter. But, as we have seen, this source of the disease in man is plainly a very small one as compared to other sources. The public is more interested in the elimination of the other sources of the disease rather than this one from the cow. To the agriculturist himself, however, the problem is a different one, and one really much more serious. The study of recent years has taught that for the health of the public the problem of bovine tuberculosis is less serious than was believed a few years ago, but for the agriculturist himself it is more serious than was formerly recognized.

In the first place, the direct loss that results to the farmer is something quite surprising. We have in our country little statistical evidence in this line, but it has been collected somewhat accurately in Germany, and it was found, for example, that in Germany in the year 1895 there was a direct loss of one and one-half million dollars to the German farmers from the condemnation as tuberculous of the carcasses of slaughtered cattle. When we remember that much of the flesh of tuberculous animals in Germany is not condemned by the in-

spector and, therefore, not comprised in their figures, this loss of one and one-half millions will give us some idea of the extent of the disease and its seriousness. Furthermore, this loss is increasing each year, and here we have statistics that are strictly reliable, because whatever may be said of the efficiency of the veterinarian inspector in detecting the disease, it is certainly a fact that more animals are being condemned in the public slaughter-houses each year and the consequent loss is becoming each year greater. In other countries the statistics are not so easily obtainable, but there is no question that in other European countries the amount of loss is rapidly increasing until it is assuming somewhat startling proportions. This cannot be otherwise, when some countries like Denmark have apparently fifty per cent. of the animals suffering from the disease in some form.

Of course the losses in indirect ways are also very great, but they cannot be estimated in figures. The loss of milk of the animals, the diminution in the fertility of tuberculous cows, the necessity of removing from the dairy herd many a valuable animal which shows the presence of this disease, add to the loss from direct slaughter no small amount. Loss is entailed too, by the increased suspicion of dairy products. Moreover, inasmuch as the disease is apparently on the increase, it is becoming more and more difficult to obtain healthy animals for breeding purposes. It has been pointed out in agricultural meetings in Germany that it is becoming very difficult to get animals free from tuberculosis to serve as breeders for the dairy herd. Veterinarians are pointing out that this difficulty is becoming greater and greater each year, and that apparently, unless the tendency is counteracted in some way, it will only be a few years when it will be an impossibility for a farmer to obtain, for breeding purposes, any animals that are not infected with this taint. In this country the trouble has not by any means reached such a stage, and yet apparently the loss is increasing here also, and unless some means are taken to counteract it we may expect that our farmers will suffer as have the farmers in Europe.

These facts are staring the agriculturists of Europe in the face, and their gravity is becoming more and more recognized. The agricultural boards in general appreciate the great gravity of the situation. They are stating over and over that *something must be done*; that unless in some way it is possible to counteract this increase in the disease the destruction of dairy

industry appears to be almost a matter of certainty. Although here the problem is not so serious, it is wise for our farmers to take into consideration the condition of the problem in Europe, and to remember that we are somewhat slowly, and yet surely, going in the same direction; we should, if possible, use our wisdom, combined with that of Europe, to stem this tide of the disease before it reaches with us a magnitude such as it at present has in certain European countries. The gravity of the problem is then an agricultural one, and it is a subject which the agricultural community is interested in handling. This point cannot be too thoroughly emphasized. While the public at large is certainly interested in keeping tuberculosis among cattle from distributing the disease among men, the problem as affecting the public at large is very slight as compared with the problem as affecting the agriculturist. If tuberculosis legislation is to be designed and adopted, its primary object is for the benefit of the farmer and not for the benefit of the public at large. Incidentally the public at large benefits, and of course must pay its share of the expense, but the primary object of tuberculosis legislation is to protect the farmer's herd and to protect him in the development and the maintaining of the dairy industry.

Are there any means now at our command for settling this gigantic problem? At the outset we may state that up to the present time there is no absolutely satisfactory means which has anywhere been put into practice. Legislation of some sort has been adopted in all European countries. The legislation is quite varied, however, and has varying success. In general, each country endeavors to protect itself against others, and with considerable degree of success. There are in most countries laws which prevent the importation of animals from abroad, except under such strict inspection as to prohibit the introduction of tuberculous animals. This same thing has been adopted in the United States to protect one State from importation from another State. But, while this method of protecting a country against others is moderately successful no country has as yet found any very satisfactory method of protecting itself against the disease within its own borders. We are, however, slowly learning methods of attack, and, as the years are passing, our ability to handle the disease is increasing. In the consideration of this question we must notice two points. First, the method of detecting the disease, and, second, the method of dealing with the herd after the disease has been detected.

DETECTION OF TUBERCULOSIS BY CLINICAL SYMPTOMS.

It is, of course, manifest that there is no possibility of dealing with tuberculosis until we have some satisfactory means of determining the presence of the disease. There are two methods which have been used for indicating its presence. The first is by means of clinical symptoms, and this, for purposes of controlling the disease, is almost useless. A skilled veterinarian is able, by means of clinical symptoms, to distinguish many cases of tuberculosis. Most advanced cases of the disease he will discover, but all of the incipient cases will escape his observation entirely, and many of the cases that are really very far developed show no external signs which the veterinarian can detect. As a result, the method of detecting the disease by means of clinical symptoms is absolutely unsatisfactory, and if we had no other means than this it would certainly be hardly possible to cope with the disease at all. In spite of the most rigid inspection of this sort the disease may run through a herd, many animals will have the disease and distribute it from one to another, and yet the veterinarian be unable to detect it early enough to prevent the disease from being distributed from animal to animal. We must admit, with all veterinarians, all scientists, and all bacteriologists, that the clinical detection of the disease is so unsatisfactory as to be practically useless in giving us adequate means for battling with this widespread disease.

DETECTION OF TUBERCULOSIS BY USE OF TUBERCULIN.

The second method of detecting the disease is the use of tuberculin; and here we come to a problem over which there has been the greatest amount of contention. The opposition has arisen from many sources and for many causes. It is well for us, however, to consider the facts clearly and to notice the condition of things in regard to the use of this much-abused test.

Accuracy of Tuberculin Test. — The first question is in regard to the accuracy of the test. Over this, as over every other point, there has been much dispute, but at the present time there is an absolutely universal consensus of opinion. Tuberculin, as a means of detecting this disease, is very accurate. By this statement it is not meant that it never makes a mistake.

In some instances of advanced tuberculosis the tuberculin fails to give any reaction. These cases are rare, however, and are of comparatively little importance, because when they do occur the clinical symptoms are so well developed that the animal will be condemned independent of tuberculin. If, therefore, we are simply thinking of the matter of the detection of the disease, the failure to detect advanced cases is of little significance. Occasionally it may perhaps fail to detect a case not so far advanced. At the other extreme it has been claimed that there are some animals which react to tuberculin but are not suffering from the disease at all. This is apparently a mistake, although, of course, it is an extremely difficult thing to disprove. There are quite a number of cases of reacting animals in which the disease has not been detected after the slaughter of an animal, but anyone who knows the difficulty of making a thorough examination of a dead carcass will see at once that such evidence is at least unsatisfactory. If the case is an incipient one, the question of discovering it by post mortem examination is almost directly dependent upon how careful a search is made by the veterinarian. Sometimes he will examine an animal for two or three hours without success, but finally, after a search of several hours, will discover somewhere a small lymphatic gland which has evidently become tuberculous. Now, such an animal is certainly infected with the disease, and, bearing in mind that we are only here considering the matter of the accuracy of the test and not its value in other respects, it is very clear that the fact that we do have such cases of seeming mistakes is a simple testimony of its accuracy. It is the general belief among those who have used tuberculin most that if the test is made in a proper way animals do not give the reaction unless they have the disease at least in an incipient form. If the test does give a reaction in animals that have seemed to have no signs of the disease, this is because the disease is so incipient that it escapes the attention of the inspector. If there are cases where a healthy animal reacts, such cases are at all events extremely rare, and probably due to improper use of the tuberculin. But to be of value the test should be used only by persons skilled in its use. For various reasons there is a growing belief that it should be used only under the direction of veterinarians or officials. In detecting the presence of tuberculosis in our animals, then, tuberculin is very accurate; too accurate, indeed, to be a guide for the indiscriminate slaughter of reacting animals.

Injurious Effects of Tuberculin.— It has been, from the first, thought by some that the use of tuberculin produces a direct injury upon the inoculated animals. This, however, is undoubtedly a mistake, and there is no longer any belief anywhere on the part of scientists that the injury thus produced is worthy of note. In the first place, the idea that it may produce the disease in a perfectly healthy animal by the inoculation is absolutely fallacious. The tuberculin does not contain the tubercle bacillus, and it is absolutely certain that it is impossible to produce a case of tuberculosis in an animal unless the tubercle bacilli are present. The use of tuberculin, therefore, certainly can never produce the disease in the inoculated animal.

It has been more widely believed, however, that the inoculation of an animal with this material has a tendency to stimulate an incipient case of tuberculosis. It has been thought that an animal with a very slight case of the disease may, after inoculation, show a very rapid extension of this disease and be speedily brought to a condition where it is beyond any use. The reasons given for this have been the apparent activity of the tuberculous infection in animals that have been slaughtered shortly after inoculation. This has been claimed, not only by agriculturists who have not understood the subject well, but also by veterinarians and bacteriologists. But here, too, we must recognize that the claim has been disproved, and that there is now a practical unanimity of opinion on the part of all who are best calculated to judge, that such an injurious effect does not occur. Even those who have been most pronounced in the claim that there is injury thus resulting from tuberculin have little by little modified their claim, until at the present time they say either that the injury which they formerly claimed does not occur, or that the stimulus of the disease is so slight that it should be absolutely neglected, in view of the great value which may arise from the use of tuberculin. Apart from two or three who hold this very moderate opinion, all bacteriologists and veterinarians unite in agreeing that there is no evidence for believing that *any* injury results. In Denmark, especially, many hundreds of thousands of animals have been inoculated, and the veterinarians say there is absolutely no reason in all their experience for believing that the tuberculin inoculation is followed by any injurious results.

Abuse of Tuberculin.— It is certain that the use of tuberculin is subject to abuse. The abuse, however, arises rather

from its use in the hands of ignorant or unscrupulous individuals than in its use in the hands of officials. It has been shown that an animal once inoculated and showing the characteristic reaction of the disease is then, to a certain extent, protected from a second inoculation. If this animal be now re-inoculated it will frequently, though not always, fail to show a second reaction until after a number of weeks or a number of months have passed. This fact has led in some countries to a fraudulent use of the tuberculin, as follows: An owner of a large herd will have all his animals privately inoculated with tuberculin. He will then select all the animals that do not react to keep, while all the reacting animals will be at once rushed to the border of the country for exportation. When they are to be imported into another country, according to the laws in most European states, they must be inoculated and only the non-reacting animals imported. But most of these animals having recently been inoculated are protected from the second inoculation, and the official test at the boundary fails to show the presence of the disease. They are, therefore, accepted as free from tuberculosis, and thus by this fraudulent means tuberculous animals are to a certain extent freely sold. Of course the remedy for this is not difficult to find. In Belgium there is a law forbidding the use of tuberculin by the private individual, and making it only possible to use it under official inspection. After such official inoculation the animals that react are marked by a notch in the ear, and from that time on anyone who sees them knows perfectly well that the animal has had tuberculosis, whatever be the result of the tuberculin test at the moment. It is not possible to emphasize too greatly the importance of this marking of animals. Every animal that has once reacted should be marked in such a way that the mark cannot be obliterated. Apparently, then, the only proper use of tuberculin must be in the hands of officers who understand its use and who will honestly use the test and properly mark all reacting animals. In this way only can the purchaser of cattle be properly protected.

INCREASE IN USE OF TUBERCULIN.

The use of tuberculin is certainly extending more and more widely every year in all European countries. There has been there the same objections to its use that there has among our own farmers. These objections have been partly well founded

and partly due to prejudice. In the first place, many of the farmers refuse the use of tuberculin, for the simple reason that they are afraid to know to what extent tuberculosis may be present in their herds. They fear that if it is known that they have a number of cattle in their herd that are infected with the disease it will be difficult for them to sell their milk, difficult for them to dispose of their cattle, and they will suffer financially from the test. They prefer to remain in ignorance and to use their animals freely as if all were healthy. This has undoubtedly been the basis of a large part of the objection to the use of tuberculin. Moreover, in some countries, and especially is this true in our own, the customs and laws have been such as to demand the immediate slaughter of all animals which react to the tuberculin test. The objection to this is too well known to need emphasis. The farmer's good sense has told him that it is needless and that it means an unnecessary waste. When, as the result of a tuberculin test, there are slaughtered a number of animals, several of which show only such a slight trace of tuberculosis as would be indicated by a single small tuberculous nodule, the farmer very rightly feels that he has been subject to trouble and to financial loss which was not demanded by the condition of things. He has rightly claimed that such animals need not be slaughtered. They are not sources of danger to the public, and perhaps not sources of danger to his herd. The farmer then blames the tuberculin test, when the blame should have been upon the law demanding the indiscriminate slaughter of reacting animals. The tuberculin test picks out too incipient cases to justify the slaughter of all animals thus reacting. This fact, coupled with the fear on the part of the farmer to know the condition of things in his herd, probably explains *all* of the real opposition that has arisen to the use of tuberculin.

The objections thus arising, however, come not from the use but from the abuse of the tuberculin test. The use of tuberculin should be for the purpose of determining the presence of the disease, and thus benefiting the farmer rather than doing him an injury. When the tuberculin is used properly, as it is now more and more rapidly being used in European countries, the farmer is universally benefited and never injured by it. He is always the gainer and not the loser. When the farmers find out, as they are gradually doing, that the test simply enables them to pick out the tuberculous animals and does not force them to lose by slaughter a large number of

animals that are still valuable, they cease to find so many objections to the use of the test, and gradually learn that it is decidedly for their advantage to have their herds tested in order that they may be on a better vantage ground to protect their herds for the future. The result is that in Europe the objections to the use of tuberculin have very largely disappeared, and are disappearing now even more rapidly. If the legislation had not been too precipitate in early years and demanded the indiscriminate slaughter of all reacting animals, it is doubtful whether any of the great opposition to the use of tuberculin would have developed. At the present time the use of tuberculin is coming to be made simply to detect the presence of the disease, so as to give the farmer, in conjunction with the veterinarian, the data upon which he can successfully, and without too great inconvenience and too great expense, deal with the subject of tuberculosis and free his herds from this curse in the future.

In general, then, the use of tuberculin is increasing, and its value is becoming every day more and more appreciated. It enables the farmer to pick out the animals which he must deal with as suffering from the disease, either in an incipient way or in a more advanced stage, and gives him a chance to battle with the disease in a successful manner. It is the one successful means of detecting the presence of the disease, but the veterinarian and the scientist are learning more and more clearly each year that it should not be used for detecting animals for the purpose of indiscriminate slaughter.

METHOD OF DEALING WITH THE TUBERCULOUS HERD.

The next question is how the farmer can deal with a herd after tuberculosis has once obtained entrance to it without too great expense and with promise of successfully handling the problem. Every attempt to get rid of tuberculosis from the herd of cattle must begin with the tuberculin test. There is very little chance for the farmer to get rid of the disease after it is in his herd, except either by getting rid of *all* of his herd and starting absolutely new, or by beginning with the tuberculin test and thus discovering *every* case of tuberculosis, even in the most incipient stage. Thus, and thus only, can he start in his attempt to purify his herd with a fair hope of success. After the tuberculous animals have once been designated in this way, the problem of what to do with them is still a se-

rious one, but one which is capable of solution. The first methods that were used were undoubtedly too severe, for, as is well known, they involved the slaughter and absolute destruction of the flesh of every animal that reacted to the tuberculin test. Such a method was too expensive to make it at all feasible. When we remember that from forty to fifty per cent. of the animals in certain countries will respond to the tuberculin test, it is perfectly manifest that such a measure would there be ruin to the dairy industry. It is simply an impossibility, and that it is an impossibility has been clearly shown by the fact that in two instances in which an attempt was made to enforce such laws, namely, in Massachusetts and in Belgium, it was necessary to abandon them. Moreover, for reasons which have already been pointed out, it is apparently needless.

Another suggestion has been adopted in certain European countries, namely, that the reacting animals must be separated from the non-reacting animals, and must be then brought to slaughter within a year. This gives the farmer time for proper fattening of the animals and for bringing them to the condition of slaughter so that he need not have the loss that would result from immediate slaughter. Of course he must run the risk at the end that when slaughtered the animals will be found so decidedly tuberculous that their flesh will be condemned, and thus the expense of the fattening will be a loss. But, inasmuch as in European countries the flesh is not all condemned from incipient tuberculosis, it will in most cases result that the animals thus fattened will yield a tolerable return to the farmer and not be total losses.

But even this less radical measure appears to be unnecessary and is not very highly regarded in the different countries of Europe. The fact is, that the more experience accumulates the more we learn that many of these incipient cases of tuberculosis are only temporary, and that the animals in question, if kept in a favorable condition, will soon recover and may live many years of useful life. It is, of course, not very easy to give accurate data in this regard, but the best data obtained have been those of Prof. Bang in Copenhagen, where for several years there has been under very close observation a large herd of animals which had at the outset a very high per cent. of tuberculosis. The animals were all inoculated with tuberculin and subsequently kept under observation for several years. Many of them after a time ceased to respond to the subsequent tests. In later years, as they were slaughtered

one by one, it was found by post mortem examination that quite a number of these animals that had in earlier years reacted to tuberculin test and had failed to react in later years showed that they had actually had the disease, but that the disease had been arrested, the animals had apparently recovered completely, and at the time of slaughter were in a healthful condition so far as concerned this disease. Now, it is impossible to fail to draw the conclusion from such facts that it is entirely needless to slaughter all animals that react from tuberculin, when we remember that many of them would still live for years without any advance of the disease, and others would probably completely recover. It is simply a question whether these animals can be prevented from contaminating the rest of the herd.

Various suggestions have been made in connection with the building up of a healthy herd. One is that no person shall purchase animals that have not been inoculated and by this test proved to be healthful. There is no question that this deserves the very greatest emphasis and should be most highly recommended. It is certainly true that our farmers, as a rule, *buy* their tuberculosis. The herd, originally free from the disease, is increased by purchase of animals that have not been tested, the purchased animals bring the infection into the herd, distribute it, and in a short time the farmer suffers. It can not therefore be too strongly emphasized that the farmer, if he wishes to keep his own herd in a healthful condition, should, where it is possible, insist that the animals that he buys shall be first tested with tuberculin and proved to be free from the disease. It has been suggested, also, in agricultural circles in Europe, that a general rule should be adopted that no premiums should ever be given to animals in the agricultural exhibits until after the animals are inoculated with tuberculin and proved to be free from the disease. Of course the animals which obtain the premiums are of special value and will in the future be used for breeding. If, therefore, no premiums are given except to animals that are tested and proved to be non-reacting, there is here one strong safeguard against the further distribution of the disease.

There is, however, at the present time prominently before all agricultural communities, as well as scientific men, one method of dealing with the tuberculous herd which appears to be not only moderately successful but quite satisfactory, and gives promise of the most excellent results with a mini-

munum expense. This method is the well known method of Prof. Bang, developed in Copenhagen, and now extending itself over Europe. It is universally spoken of in high terms by bacteriologists and veterinarians who know anything about its results. They recommend it as the only feasible method yet devised for meeting the problem. The object of the method is to enable the owner of a herd of cattle infected with tuberculosis to obtain a healthy herd without subjecting himself to much of any expense, and with a minimum of inconvenience. The general method is well known, but a description of its application may not be out of place here. The method of Prof. Bang is as follows :

1. The farmer consents to follow out accurately directions given him by the veterinarian. This is a primal necessity, because if the directions are not followed out with strict accuracy the whole plan is absolutely useless.

2. After the farmer has consented to the proper conditions, the whole herd is tested with tuberculin and then the animals separated into three sections.

3. The first section contains those that neither show clinical signs of tuberculosis nor react to tuberculin. These are presumably healthy and are put into a barn by themselves. This barn must, if previously occupied, be disinfected before the healthy animals are put into it.

4. The second section contains those that show clinical symptoms of the disease such as to indicate an advanced case of tuberculosis or such as show tuberculosis in the udders. These animals are slaughtered *at once*, submitted to proper inspection and the flesh used or destroyed in accordance with the verdict of the inspectors.

5. The third lot contains the animals that are apparently healthy, with no external signs of tuberculosis, but that have reacted to the tuberculin test. These are presumably animals with incipient tuberculosis. They are put in a separate barn and kept absolutely isolated from the healthy herd.

The isolation of these two lots of animals from each other must be absolute, though it is not necessary that they should be in separate buildings. In the barn where the first experiments were made there was a long cattle barn with some two hundred animals in it. After the inoculation a partition was built in the barn separating it into two divisions, in one of which were kept the healthy, and in the other the reacting, animals. This partition absolutely separated the two herds from

each other, but did not require the building of any new cattle stalls.

6. These two herds, after the separation, must be kept absolutely isolated from each other. They are never allowed to come together, never allowed to drink out of the same troughs, and, so far as possible, are attended by different attendants, so that persons going from the infected herd can have no chance for carrying the disease into the healthy herd upon his boots or clothing. The animals are used as usual, but the milk from the reacting herd is, as a rule, sterilized before being used.

7. The calves which are born from animals in the reacting herd are, after the first three days, separated from their mothers and are brought up wholly on sterilized milk. Before these calves are allowed to associate with the healthy herd they are themselves inoculated with tuberculin, and, of course, if they show any reaction they are kept from the healthy herd, and either slaughtered or put with the reacting herd.

8. After six months the animals in the healthy herd are inoculated again, and any who now show a reaction are removed at once and put with the reacting herd. This process is repeated every six months under proper supervision, and in all cases the reacting animals are separated from the healthy herd and put with the others.

9. No animal that has once entered the reacting herd is ever put back among the herd of healthy animals, even though it may show evidence of having entirely recovered.

As this process is continued year after year the animals in the reacting herd are gradually gotten rid of as they get old or as they are bought to slaughter; the healthy herd is always increased by animals that are shown to be free from the disease, and thus the expectation has been that the healthy herd will gradually increase while the reacting herd decreases, until finally the disease will practically disappear. The only expense to the farmer in all this would be that of building the partition in the barn and of seeing that the animals are kept isolated from each other. The State itself in these experiments undertakes the expense of furnishing the tuberculin and performing the inoculation.

This, in general, has been the method adopted by Prof. Bang, and now in use under his inspection for several years. The results have been very favorable. The partition in the barn under Prof. Bang's inspection is changed year after year

as the size of the two herds of healthful and reacting animals change. It has been found necessary each year to move the partition in such a way as to make the reacting herd smaller and smaller, while the healthy herd is larger and larger.

The results are shown in the following table:

Year.	No. of animals in re-acting herd.	No. in sound herd.	No. re-acting in the sound division.
1892.....	131	77	—
1893.....	90	103	10
1894.....	81	122	2
1895.....	69	136	3
1896.....	54	149	7
1897.....	48	155	6

It will be seen that while the number of the reacting herd has decreased from 131 to 48, that of the sound herd has increased from 77 to 155. It will be seen also that each year a few of the animals left in the sound herd become infected, but that the number is small. Evidently this herd is slowly getting rid of the disease.

The same method has been adopted quite widely in the dairy herds in Denmark, and the results in general have been similar to those obtained under the personal direction of Prof. Bang. But they have not been universally successful. In some cases the decrease in the reacting animals has been very slow, in other cases it has been hardly noticeable. In most of the herds, however, it has been possible to show that the cause has been the fact that the farmer has failed to obey the directions for careful isolation; that in some way, either by having the door in the partition between the two stalls, or by having the same attendants, or by some other means, there has been communication between the reacting herd and the healthful herd. Under these circumstances the disease has been carried from the one to the other and the healthful herd has, therefore, been constantly infected. It is certainly a fact that even under the best circumstances new cases of tuberculosis occasionally occur in the reacting herd, indicating, of course, some source of contamination either from the other animals or from the attendants. But in spite of this partial failure the method has been in general very successful, and is apparently now in such successful operation in many places in Denmark that the farmers are slowly getting rid of tuberculosis from their herd.

The process is, of course, slow. A quicker way would doubtless be to kill at once all the reacting animals. But the merit of the method of Prof. Bang is that it is done at an expense so small as to be hardly worth consideration.

The success of this method as adopted by Prof. Bang in Copenhagen has been so great as to excite general interest all over Europe. Many of the bacteriologists and veterinarians of European countries have visited Copenhagen for the purpose of seeing the method actually in operation, and all of them come back with the belief that the method thus developed is the only one that is practical and which bids fair to be a means of successfully combating this disease. At the present time this method is being recommended almost universally in European countries. Illustrative experiments are being started in other countries for the purpose of showing the farmers by demonstration how the method works. The expenses of the inoculation are in general borne by the public funds, and not by the farmer, and it is a rapidly growing belief that this method as devised by Prof. Bang is practical, and if applied with wisdom will enable our farmers to handle the subject in such a way as to rid their herds at least in large measure of the disease without any great expense to them, and with a minimum of trouble.

In these experiments it has been found, not unnaturally, that there has been greater success with young farmers than with older ones. The young farmer is more open to conviction of the value of the method, more ready to learn methods and applies them with stricter accuracy. The older farmer cannot so easily be taught new methods. As a result the young farmer will almost always succeed in improving the condition of his herd in this way, while the older farmer has less success. It has been abundantly shown, however, that eternal vigilance is absolutely necessary. If the farmer becomes careless, the whole procedure becomes useless, half-way methods being as good as none.

The best method of introducing this procedure among farmers is, perhaps, not as yet definitely settled in different countries. It seems to be a general belief that the adoption of this method of Prof. Bang must be at first voluntary on the part of the farmers who are interested in the subject. If it was made compulsory it would be a failure. It can only succeed where the farmer has interest enough to lead him to adopt and carry out strictly the rules for isolation given him. If it

were a matter of law instead of volition the farmer would fail to give it personal supervision, and the experiment would fail in such a large majority of cases as to bring the whole plan into disrepute. It will only succeed where the farmer will take a personal interest in the carrying out of the scheme. It is hoped, however, after a few years had demonstrated by examples in numerous localities the feasibility of the plan, that legislation looking in this direction might be feasible. At the outset it would be futile. It is, however, a general belief that the expenses connected with preparing the tuberculin for the inoculation of the animals should be free to the farmer. This is advisable for two reasons. In the first place, it will make the farmer much more inclined to adopt the scheme than if the original inoculation were a matter of expense to him; and, secondly, it insures that the tuberculin and the methods of inoculation used are satisfactory inasmuch as they will be under official inspection. Already two or three of the European countries have advanced as far as this, giving the free use of tuberculin to such farmers as are willing to adopt the methods suggested along the lines indicated above.

One of the most important phases of the adoption of this method of Prof. Bang is that the young animals should be inoculated. This is of so much importance that it deserves to be considered by itself and should be recommended entirely apart from the general adoption of the method of Prof. Bang. The testing of young cattle by tuberculin will detect at once the animals which have already yielded to tuberculosis. These animals, above all others, should be excluded from the herd. If they have taken the disease in the earlier period of their life, it is practically certain that the disease will advance in them rapidly. They will not only be of no use to the herd in the future, but will become a menace to the rest of the animals. Even if they should recover from this attack, the fact that they have yielded to the disease early in life shows that they have weak resisting power. On the other hand a slaughter of such young animals is not a matter of such serious expense as it is later. The flesh can be sold with proper precaution, and the animals have not yet become valuable as dairy animals. It is, therefore, above all things desirable, if a farmer desires to free himself from this great burden, that *all* calves should be tested with tuberculin, and no calf should ever be allowed to join the healthy herd until it has proved by failure to respond to this test that it is free from every taint of this disease.

It is quite a confident expectation on the part of European scientists that the method as outlined here and as is now being slowly adopted, is practical, and is destined to be successful. The European agriculturists and bacteriologists are promising to the farmers that if they will only adopt this method *and carefully follow it up*, they may expect the practical disappearance of tuberculosis among their herds inside of ten or fifteen years. That the disease will absolutely disappear is not expected, but it is a confident belief that by the use of the method as suggested by Prof. Bang it can be in a comparatively few years so reduced in amount that it will not be a menace to agriculture. The significant point in regard to the whole is that this reduction in the tuberculosis can be accomplished with a very small expense to the State for veterinary services, and with practically no expense to the farmer beyond that of dividing his cattle into two herds and keeping them isolated from each other. It is evident that this method of Prof. Bang is more readily applicable to a large herd than a small one. A farmer who owns only two or three cows has a very different problem from one with a large herd. He is less likely to have the disease in these animals and may probably deal with it better by slaughter than an attempt to isolate a single cow.

USE OF ANIMALS REACTING WITH TUBERCULIN.

Meantime, the question arises as to how the animals in reacting herds shall be treated, whether their milk can be used and whether they can be slaughtered for food as can the animals in the untainted herd.

The answer to this so far as concerns the use of the flesh of these animals is very simple, although it may demand certain new regulations at least in most parts of our own country. As we have already seen, there is no reason for rejecting the use of the flesh of an animal that is suffering from an incipient case of tuberculosis. With a proper inspection it is perfectly clear in the light of the evidence that has accumulated in the last five years, that the flesh of animals in the reacting herd may be sold and eaten. If it is to be thus sold, however, there is needed a certain amount of inspection of slaughtered animals. This requires that the flesh be slaughtered in public slaughter-houses or at all events under the direction of public inspectors. To what an extent this is possible in different states of our country is not a question to be answered at this place, but in

the European countries such an inspection is almost un- and under such conditions there is no reason in the world for the animals in the reacting herd should not be used for just as freely as are the animals in the non-reacting herd.

Again, the question as to whether the animals in the reacting herd should be used for breeding purposes is one of importance. There seems to be no reason for rejecting absolutely the animals born in the reacting herd. As already stated, tuberculosis is only in very rare instances hereditary, and if the calves from the reacting animals are separated from their mothers by the third day, and are then brought up on boiled milk there is no reason for thinking that they are more likely to have tuberculosis. It is, of course, possible that they have inherited from their mothers a slightly increased tendency to take the disease. The fact that the mother had tuberculosis indicates that her power of resistance against the disease is less than that of the animals in the non-reacting herd, but it is quite possible, therefore, indeed probable, that her calves are in a similar way be more prone to take the disease than the calves from the non-reacting herd. Where it is possible, therefore, to use the animals from the reacting herd for slaughter while young, and retain only those from the reacting herd for the dairy and for breeding purposes in the future, such a procedure is certainly advisable. But if it is necessary, and with the precautions of rearing calves on boiled milk and testing them with tuberculin before they are milked, with the non-reacting herd, there are no special reasons why such calves should not be kept for future production.

USE OF MILK OF COWS REACTING WITH TUBERCULOSIS

A much more puzzling question arises, at least in this country, as to the use of the milk of the reacting herd. In Europe this question is one of less importance from the fact that the habit of sterilizing the milk has become so widespread. In such places the problem is already solved. There is no doubt that the sterilization of milk destroys all danger of tuberculous infection, and in Continental Europe it is only necessary to say that the milk from the reacting herd must be sterilized at least pasteurized before it is used. The use of sterilized milk is becoming more and more common in European countries, and, therefore, the problem as to the distribution of tuberculosis by means of milk is disappearing. All of the

doctors in the European countries are taught the necessity of sterilizing milk, and, to a greater or less extent, even the children are being taught the same fact in the schools. The result of this is certain to be that in a very short time the sterilization of milk for drinking purposes will there perhaps be almost universal; so that the problem as to what can be done with the milk from the reacting herd is already practically solved in continental nations.

In England and the United States, however, the problem is a very different one because, at least at the present time, the practice of sterilizing milk has not extended widely, and the largest part of the milk which is used as food is used without sterilization. What can be done in these countries with the milk from the reacting herd is, therefore, a more puzzling question than in countries where sterilization is common. The same question confronts continental nations in the use of butter which is commonly made from unsterilized cream. From what has already been pointed out it is clear that the danger of distribution of the disease through milk or butter is very slight, even where the milk is used raw, and that there is no statistical evidence for indicating that even in England and the United States milk has been to any considerable degree a source of tuberculosis in mankind. Under these circumstances it seems that, even in these countries also, with a certain amount of precaution, it may be perfectly safe to recommend that milk from the reacting herd be used. It is, however, necessary that certain precautions should be taken. In the first place, all animals suffering from generalized tuberculosis, showing clinical symptoms of the disease, such as emaciation and cough, and, secondly, that all animals showing the slightest trace of an udder disease, should be excluded even from the reacting herd. Such animals are certainly a menace to the public health, as well as the health of the herd. They must be slaughtered and consequently rigidly excluded from any chance of sending their milk to the public. Every one will recognize the necessity of this, even those who are inclined to put the danger from tuberculosis through milk at its minimum. No one will question that an animal suffering from an udder disease, whether it be tuberculosis or otherwise, or that an animal in the later stages of tuberculosis, should be prevented from furnishing the public with milk.

With this precaution it is perhaps impractical and unnecessary to limit further the use of the milk from the reacting herd.

Beyond question it is desirable and perhaps necessary to recommend that for young children the milk should not be used raw, but this recommendation is dependent not simply upon the matter of tuberculosis, but upon other factors. As is well known, milk distributes other diseases besides tuberculosis, such as scarlet fever, diphtheria, typhoid fever, etc. A young infant is extremely sensitive to the attack of various diseases, and under these circumstances in modern times it is certainly unsafe to feed a young child upon raw milk. For other reasons, therefore, entirely apart from tuberculosis, it is necessary that the necessity of pasteurization of milk for infants should be strenuously urged. Year by year, even in the United States, this habit of pasteurizing or sterilizing milk for infants is becoming better understood and more used, and with it the danger from tuberculosis and other diseases distributed by the milk is disappearing. For adults, as we have already seen, there appears to be practically no danger of tuberculosis as derived from milk that is used as food. That there is absolutely no danger is not claimed by anyone, but the danger is very small in comparison with the very many other sources of contagion to which the adult is constantly exposed. When we remember that an adult is almost constantly exposed to tuberculosis by breathing, it is plain that we are not going to increase his safety to any considerable extent simply by advising him not to drink milk which may under rare circumstances contain some tuberculosis germs. The danger from this source is so small, compared to that from other sources, that it does not materially increase the probability of his taking the disease. With the precaution, then, that animals suffering from udder diseases be excluded from furnishing milk to the public, and that the milk that is used for infant feeding be pasteurized or sterilized, there seems to be, according to the best knowledge of to-day, no reason why the milk from the reacting herd should not be used as well as the milk from the non-reacting herd.

Of course, if this method is adopted it will not be very long before the general tendency of business produces a different condition of things. It will not be long before the farmer who has thus separated his herd into a reacting and a non-reacting lot will sell the milk from the non-reacting lot at an advanced price, and use the fact that every animal that furnishes the milk has been proved to be free from the disease as a means of advertisement. This will probably in time result in the

gradual exclusion of the non-reacting herd. The farmer will, **of course**, seek to get rid of the animals in the reacting herd as **rapidly** as he can do this without loss, and in time the reacting herd will probably very largely disappear. All of this will, **of course**, hasten the reduction of the number of reacting animals.

It must not be understood that the conservative recommendations that have been here suggested are universally agreed upon by bacteriologists or veterinarians in Europe or elsewhere as sufficient. Very much more drastic measures are **frequently** suggested and advised. There are still those who **insist** that all animals reacting from tuberculin should be slaughtered; that under present conditions of things it is unsafe to use the flesh of such animals under any conditions, that slaughter-house inspection cannot be enforced sufficiently to **make** it safe; and that it is absolutely unsafe to recommend, even tentatively, the use of the milk of animals that have reacted to the tuberculin test. It is pointed out, and of course properly pointed out, that it is impossible to tell when such a reacting animal may acquire tuberculosis in the udder, and, even though at the time of inoculation the disease may be incipient and the milk healthful, it is perfectly possible that at any minute the disease may become located in the milk gland and the milk become contaminated. These are, of course, undoubtedly, facts, and tend to increase the question as to how safe it is to use raw milk of reacting animals, even under any conditions. Nevertheless, the present indications that the number of cases of tuberculosis as derived from milk is so small, and the almost universal opinion that such cases are confined to children, lead to a growing belief that the milk of reacting animals may be used, if precautions are taken to ensure its pasteurization or its sterilization, for use by infants.

III. PRACTICAL CONCLUSIONS.

There are several practical conclusions to be drawn from the facts as they have been pointed out in the previous pages, and, while these conclusions have already been mostly indicated, a summary of the more important may not be out of place.

If a farmer owns a herd free from tuberculosis he wishes to know how to preserve it in this condition. His only sure

method of doing this is by adopting some such rules as the following:

1. Never allow new animals to enter the herd unless the tuberculin test has shown them free from the disease.
2. If skim-milk is obtained from a creamery, do not feed it to calves (or pigs) without boiling.
3. Do not allow strange animals to mingle with the herd or enter the stalls occupied by the healthy animals.
4. Do not allow consumptive persons to attend the cattle or prepare their food.

These rules will probably keep the disease away from the herd. The rule to buy no animals without the guarantee of the tuberculin test is the most important one of them all.

The farmer who already has the disease in his herd wants to know how to get rid of it. To do this he must build up a healthy herd. This is to be done as follows: In the first place, the task of eradicating tuberculosis from our herds must begin with the farmer and cannot begin with legislation. It is the farmer who is interested in the herd which he owns that must start this conflict with tuberculosis. Legislation may assist. Legislation may direct and advise, but unless the farmer himself takes the subject in hand and begins the battle, legislation will be very largely futile. Second, the key to the whole problem of getting rid of tuberculosis in our herds is isolation, and not universal slaughter. If we can isolate all animals as soon as they show even incipient signs of this disease from the others, we have every reason to believe that we can soon reduce the trouble and bring it within manageable limits. This isolation simply means a separation of the animals from the others, and does not mean their slaughter or their loss. It means simply that they are prevented from contaminating the rest of the herd.

For the purpose of this isolation there is only one promising method of attack, and that is by the use of tuberculin. Clinical symptoms alone are not sufficient. Tuberculin is perfectly satisfactory for this purpose, since it will, beyond question pick out every case of incipient tuberculosis and thus give the farmer data by means of which he can undertake this isolation for the purpose of getting rid of the disease. Without the use of tuberculin there is little use for the farmer attempting anything. He must let things drift from bad to worse, only picking out the worst cases.

This isolation of the animals must be complete, it must be

accompanied by care in building up the herd. Not only must the reacting animals be kept from contact with the healthy herd, but animals in the healthy herd that show any suspicious symptoms, cough, foul breath, nodules under the skin, diseased udders, swollen joints, etc., should be at once removed. At intervals of six months the tuberculin test should be repeated in the healthy herd. Care should be exercised in purchasing new animals, and each fresh animal should be tested with tuberculin before being admitted to the herd. Strange cattle should be kept out of the barn and cattle-yards. All calves should be tested before being admitted to the herd, and, so far as possible, the calves that are retained should be those from healthy animals, which have probably greater resistance to the disease than those from reacting animals. This isolation should also be attended with care in regard to the health of the attendants, and, until we know more definitely that the variety of the bacillus found in man is different from that in cattle, it is eminently desirable that the attendants that wait upon the animals or prepare their food should themselves be free from tuberculosis, and spitting in the barn or cowyard should be strictly forbidden. One bacteriologist goes so far as to say isolation will never be of practical use until the attendants themselves are tested with tuberculin and the reacting attendants isolated.

Isolation should be accompanied by frequent disinfection. Before the non-reacting animals are put into a barn by themselves this barn should be disinfected, and whenever the partition which separates the two herds from each other is removed, this should be accompanied by thorough disinfection. Indeed, so long as there is any tuberculosis in the herd, disinfection of the cow stalls should follow at certain intervals. The details of this matter of disinfection must be left to a veterinarian's suggestion.

Beyond question the farmer will be much aided in his struggle to build up a healthy herd if he can give his animals more air and light. Light is one of the means of destroying tubercle bacilli, and good fresh air and plenty of it is one of the best protections that the animal has against acquiring the disease. An animal that uses his lungs constantly, breathing large quantities of fresh air, is very much less likely to take the disease than one that uses the lungs not so vigorously and breathes more or less impure air. Better hygienic conditions will help keep a herd healthy, but the farmer must not believe

that they alone can get rid of the disease after it is once in the herd.

When the question comes to each farmer as to the proper method to be pursued on his farm there must, of course, be left much room for individual conditions. The isolation method adopted by Prof. Bang is evidently adapted to a large herd, but not to a small one. If a farmer has half a dozen cows, one of which is tuberculous, it is manifestly an absurdity to adopt the isolation method for the one cow. It would be much cheaper to slaughter the animal outright. Thus in all cases the farmer must choose the most feasible method for his conditions. But he must remember that the only method by which he can preserve his herd is not to allow any animal that reacts to tuberculin to associate with his perfectly sound animals. If he has such reacting animals in his herd, whether the herd be large or small, he must suffer loss, and he must himself decide whether he chooses the loss from immediate slaughter, or the slight expense of isolation, or the greater and more lasting expense of the spread of the disease through his herd from the reacting animal as a starting point.

The practical difficulty in the way of eradicating tuberculosis by this simple method is in the lack of interest on the part of the farmer. While some of our agricultural communities have become quite agitated over the matter, the great bulk of farmers are not interested in it and have no desire to do anything in the matter. They do not want any legislation, nor do they want any extension of the tuberculin test. They do not appreciate the gravity of the matter to themselves; they do not feel that the disease is threatening agriculture, especially if it has not happened to attack their herd. As long as such lack of interest is found among our agricultural communities it is hardly possible to hope for any successful combat against this serious menace. For that purpose, probably the most important thing that can be done at the present time is to *educate* our farmers as to the condition of things. If the farmer can be brought to understand thoroughly that this disease is one that threatens him, that it is increasing in our midst, that it means a great financial loss to him, that it is bidding fair seriously to injure the dairy industry — if the farmer can once be brought to understand thoroughly these facts which have now become sadly demonstrated in the agricultural communities of Europe, then he will be ready to accept the simple methods of combating the disease which are being

pointed out. Those, therefore, who are interested in the subject of tuberculosis should lose no occasion to emphasize to the farming community the significance of the problem from the standpoint of the farmer. Anything in the way of distributing information will be a step toward the final conquering of this disease. But tuberculosis cannot be conquered by our agricultural community until its significance from the standpoint of the farmer is thoroughly appreciated.

It is very clear, moreover, that the longer we wait in this connection, the greater will be the problem. There seems to be little question that tuberculosis is increasing in spite of the difficulty in interpreting statistics. It is, at all events, an almost universal belief that this is the case in Europe, and probably also in America. If the disease in our herds is increasing as rapidly as seems to be true, it is perfectly clear that the longer the farmers wait before attempting the active campaign against tuberculosis, the greater will be their difficulty in waging the battle, the greater will be the expense to which they are subjected, the greater will be the loss that devolves upon them, to say nothing of the loss which devolves upon the public at large. It is extremely desirable, therefore, that our agricultural boards should use every endeavor to bring the facts to the attention of our farmers, and that speedily, in order that the contest against the disease may be taken up as soon as possible, and that thus the battle may be made easier and the success less expensive and more sure.

LEGISLATION.

This is not the place for suggestions as to legislation in regard to the matter of tuberculosis. Every nation of Europe and every State in this country has adopted some sort of legislation, but the great difference in the laws that have been adopted show wide differences of opinion as to the possibility and the feasibility of handling the matter through public statute. There is no question, however, that some things should be done by legislation. Legislation is demanded to a certain extent by the farmer, but even more by the public. The only suggestions that it may be wise to make at this place are that legislation should at all events be directed toward three points:

1. Public legislation should in some way insure such an inspection of flesh as to make it possible to use the flesh of

reacting animals without danger to the public and without too great loss to the owner. This, of course, should be along the line of public slaughter-houses and public inspectors of meat.

2. Legislation should be such as to make it impossible that milk from an animal suffering from udder tuberculosis or from advanced generalized tuberculosis should be distributed freely to the public for consumption.

3. Legislation should be devised which shall look toward giving government aid to such farmers as are willing to undertake the battle against tuberculosis in an intelligent way. This legislation should at all events offer free use of tuberculin under proper inspection to such farmers as are willing to adopt regulations which shall be devised by inspectors for the purpose of isolating the reacting animals.

Further suggestions in regard to legislation would be out of place here, but there is a task devolving upon the farmer and upon the legislator which must certainly be accomplished in the next few years. If our farmers do not wish their dairy industry to be menaced and perhaps ruined by the wider spreading of this serious disease it is time for them to become acquainted with the facts, and be ready to undertake the only practical method that has yet been suggested for getting rid of the disease, namely, isolation of all animals that show even the slightest taint of tuberculosis.

SOME PRACTICAL APPLICATIONS OF BACTERIOLOGY IN EUROPEAN DAIRYING.

BY H. W. CONN.

I. BACTERIOLOGY AND THE MILK SUPPLY IN EUROPEAN CITIES.

It is now about a dozen years since bacteriologists have turned especial attention to the subject of dairy bacteriology. During that time a large amount of information interesting to the scientist has been obtained, and this information has accumulated with especial rapidity in the last few years. Although the subject has been studied chiefly from a scientific standpoint, it is natural to expect that some facts have been discovered which might be put to practical use in dairying. This has been found to be the case, and in many respects the dairying industry has been very decidedly changed, if not almost completely revolutionized, by the application of facts which have been discovered in connection with dairy bacteriology. These changes have, of course, occurred somewhat rapidly. At the same time they have occurred in such an unpretentious way that most people hardly realize the extent to which dairy methods have been modified by facts discovered along these lines. The present paper will review certain aspects of the dairying industry in Europe for the purpose of illustrating how our modern methods have been influenced by dairy bacteriology.

CHIEF DISCOVERIES OF DAIRY BACTERIOLOGY.

The facts discovered in relation of bacteria to milk are very numerous, some of them having very highly important practical bearings and others having only scientific interest. In order to understand our subject more accurately it will be necessary, in the first place, to summarize the important facts which dairy bacteriology has disclosed, even though these facts may be familiar to everyone. The more important discoveries which have resulted from this line of study are as follows:

First, pure milk as secreted from the gland of the healthy animal, if kept free from external contamination, will not sour

or ferment, but may be kept indefinitely without any change taking place that is noticeable.

Second, all the ordinary changes which occur in milk after being drawn from the cow are due to the presence of bacteria in the milk. This includes not only the common souring, but all of the other changes which occur at intervals to trouble the dairymen.

Third, the bacteria which produce these changes are all secondary contaminations and do not belong to the milk as secreted from the gland provided the gland be healthy.

Fourth, the sources from which the bacteria that contaminate the milk are derived are several. At the head stands the cow herself. Bacteria lurk in the milk ducts. They adhere to the outside of the animal, clinging to the hairs, and, during the milking, find their way into the milk in great abundance. Next, the vessels in which the milk is drawn and in which it is kept are almost never clean, and contain bacteria in great numbers, ready to grow as soon as milk is placed in the vessel. Again, the dust of the air in the milking stall is a source of contamination. The extent of contamination from this source will vary widely and will be especially abundant when the milk stall is full of the dust from newly-disturbed hay. Lastly, the milker himself, his hands and his clothing, are sources of contamination.

Fifth, the action of the bacteria upon milk in producing undesirable changes is dependent upon temperature, for the bacteria in question grow slightly, if at all, at temperatures near freezing, and grow rapidly at warmer temperatures.

A second series of facts of perhaps even greater importance has been discovered in connection with the study of milk as a distributor of disease. The past ten years has shown beyond peradventure that milk is a prolific means by which certain diseases are distributed in man. We have learned that milk is, at the same time man's *best* food as determined by its chemistry and by its ease of digestion and assimilation, and the *most dangerous* food, from the fact that when improperly handled it may be the means of distributing disease to mankind.

The diseases which we have learned in these few years are distributed by milk are, however, not numerous. They are as follows: Tuberculosis, which comes directly from animals suffering from the disease and may be under special circumstances transmitted to man; diphtheria and scarlet fever,

two diseases which apparently also attack the cow and may be transmitted from the cow to man by means of milk. In regard to these two diseases, however, it must be stated that it is not as yet positive that they can be transmitted to man from a cow suffering from the diseases, although the evidence in our possession at the present time looks in that direction. Certain it is, however, that the milk may become contaminated from some secondary source with the germs of these diseases, and then the disease be transmitted to man.

Typhoid fever and cholera and a variety of diarrhoeal diseases especially common in children are also transmitted by means of milk. In these cases, however, it appears that the contamination with the bacteria is always secondary. The cow herself does not suffer from these diseases, but bacteria from some source of contamination which get into the milk *after* it is drawn from the cow may be the cause of them. These are the important facts in briefest outline, which have been determined in connection with dairy bacteriology and which have led to very great changes in dairy methods.

APPLICATIONS OF SOME OF THESE FACTS.

It is, of course, impossible to enumerate all of the minor changes in dairy management which have been produced in dairying through all civilized communities by knowledge of the facts above mentioned. The treatment of the cow, and the treatment of the milk from the very beginning to the time it is consumed by man, are modified in countless little details in accordance with the facts that are known. The general change that has been introduced is quite comprehensively expressed by the statement that dairy methods have been so altered in the last ten years that the milk from a time immediately preceding the milking to the time when it is delivered to the consumer is carefully guarded against contamination. Farmers in civilized communities have learned the chance and the danger of such contamination, and they have therefore been slowly but effectually adopting methods of protecting the milk.

This occurs in the first place in the stable. Recognizing that the cow is one of the chief sources of trouble, attention is given to her. She is kept cleaner than was thought necessary a few years ago. Her udder is in many cases washed with warm water; the teats may be moistened before milking, or

perhaps washed with a disinfectant solution, which although of course not a very common procedure, does occur in many dairies where especial care is taken. In the better class of dairies it is thought as necessary to keep the cow carefully cleaned as it is to care for the horse, and the old condition of filth in which the animals were allowed to live is being improved.

The bedding which the animals use has been also more or less changed in view of the facts that have been discovered. Bacteriologists have shown that many of the most perplexing difficulties which the dairyman encounters in the keeping properties of his milk may be traced directly to the bedding. Instances of slimy milk and bitter milk which have troubled dairymen for a long time have been traced to the fact that the bedding used by the animals is infected with a certain malign species of bacteria, and that a change of bedding produces a mitigation of the evil at once. This of course gives the farmer a new vantage ground from which he can deal with troublesome affections in his dairy.

It has been shown abundantly that a second serious source of trouble in dairy processes is in connection with the manure, for from this source many of the most troublesome kinds of bacteria are derived, which, finding their way into the milk, give rise to the most mischievous effects and produce the greatest amount of irritation to the dairyman. In short, our more intelligent dairymen have learned that in the cow stall strict cleanliness is a necessity for successful dairying.

Very great change has been effected in the treatment of the milk vessels by means of bacteriological discoveries. In the first place, it is slowly becoming realized by dairymen that ordinary washing, or washing with soda, or washing with boiling water, does *not* serve to clean the milk vessels, and that after any such treatment, which was always regarded as sufficient a few years ago, bacteria will be left in the milk vessels in great quantity, ready to produce trouble as soon as the milk is placed therein. As a result, new methods of washing vessels have been introduced, most of which depend upon a treatment with superheated steam, which produces heat sufficient to destroy at least a large portion of the bacteria in the vessels.

One of the most striking changes in this respect which we notice to-day is the very rapidly growing tendency of distributing milk from the central supply not in cans from which it is to ladled out to the individual customer, but in glass

bottles, which are owned by the dealer, which are washed and sterilized by him, and which are filled and sealed in the central milk-distributing station. The advantages of this method are very great and its expense is apparently so slight that it is being adopted more and more widely by the milk supply companies. The bottles in question can be much more carefully washed in the factory than in the homes of the consumer, since they can be thoroughly sterilized by heat with very little trouble, and the milk which is placed in such bottles and sealed at the factory is certain to have the best possible chance of keeping. When the dairyman is obliged to depend upon the thoroughness of the washing of the milk vessels on the part of the consumer, he has learned by experience that great trouble arises from the lack of care in the individual houses. A large part of this source of trouble is removed by the use of glass bottles sealed by the dealer, and for this reason, if for no other, the use of such a method of distributing milk is rapidly extending. It is claimed by some companies that the expense is actually less than the older method of distributing milk. The milk can be bottled mechanically in the factory by a grade of help that can be obtained at wages considerably less than must be paid to employes who are obliged to travel with the distributing cart and measure out the milk to each customer, and, after being thus bottled, the distribution can again be carried out more rapidly and with a cheaper grade of help than in the older method. The saving of expense in this way is nearly enough to compensate for the cost of the bottles and their sterilization and the breakage which occurs in the process. Judging from the tendency of dairying at the present day, this method of handling milk is sure to increase and perhaps become almost universal in the course of time.

The fact that a considerable portion of the contaminating bacteria which produce troublesome changes in milk comes from dirt of various kinds which get into the milk during or after the milking, has led to the quite general adoption of new and more careful methods of cleaning the milk. This is done in some places by simply filtering through sand, large filters being used made of alternate layers of carefully cleaned angular grains of sand and cotton, and through these the milk passes with considerable rapidity. During its passage all of the particles of dirt of any considerable size are removed, and the keeping properties of the milk are quite noticeably increased. Such filtering does not indeed remove the bacteria

from milk. Bacteria are so small that no method of filtering has been, or probably can be, devised which can remove them and not also remove the fat particles from the milk. Such a filtering only removes the larger particles of dirt, but this is itself useful. In other cases the cleaning is produced by centrifugal force, the milk being passed through a special machine, which is something of the same nature as the separator, but in which the revolutions are less rapid and not sufficient to separate the cream from the milk, but are sufficient to separate all of the heavier particles of filth. Such a cleaning by filtration or by centrifugal force is of decided value to the purity of the milk, and the better milk companies in European cities are adopting the one or the other of these two methods.

An incidental result has been in the adoption of cement floors in most of the better establishments that have to do with the distribution of milk. The old style of wooden floors has been found to become so thoroughly impregnated with bacteria and so impossible to clean that they have been quite generally abandoned. Indeed, in some cities there is a police regulation that milk shall not be allowed to stand for any length of time in rooms with wooden floors. As a result, the use of cement flooring is rapidly extending and has been almost universally adopted. This change may be beyond question traced largely to the knowledge of bacteriology.

It has of course long been known that in order to keep milk it must be kept cold. Nevertheless, some of the facts discovered in this connection in recent years have been of practical value. It has been learned that the bacteria grow most readily, as a rule, at temperatures near that of the body of the cow and, therefore, when the milk is drawn from the cow it is at a temperature at which the bacteria grow most vigorously. As a result of this fact there has been introduced, almost universally, the method of cooling the milk to as low a temperature as possible *immediately* after it is drawn from the cow. For accomplishing this, a considerable variety of forms of apparatus have been invented in the form of milk coolers which use either cold water or ice, and through which the milk is allowed to pass at once after being drawn from the cow. The advantage of this cooling is very great indeed, and it has made possible the extension of the milk industry in places and under circumstances that would have been impossible otherwise. In European dairies this matter is of even more importance than in American dairying. One of the most striking differences

between dairying in Europe and in America is the slight use of ice in the European dairies. The milk which is brought into the cities is almost never cooled with ice. Even in the northern countries like Denmark, where ice might be supposed to be at least as easily obtained as in New England, we find that the use of ice is comparatively slight, and the milk which is brought into the cities is not brought in upon ice cars, but is hurried in as quickly as possible without any attempt at artificial cooling. Under these conditions, of course it is clear that the value of the original cooling of milk to as low a temperature as possible with cold water is a very great one. It is the one universal means of cooling milk now adopted in Europe.

MILK AS A DISEASE DISTRIBUTOR.

Leaving, now, such miscellaneous effects we notice the changes which the knowledge of milk as a distributor of disease has produced in dairy methods. The first fact which comes to our notice is that there is everywhere an endeavor made to exclude from the herd which supplies public milk every animal with any trace of udder disease, no matter what that udder disease may be. It has been shown conclusively that udder diseases are always sources of danger to one who drinks the milk. Sometimes these troubles are of tuberculous nature, and then there is danger of tuberculosis. More commonly, however, the udder troubles are not tuberculous. But the bacteria which get into the milk from a simple inflamed udder are frequently those which cause intestinal troubles in children and in adults. Evidence is abundant and satisfactory which shows that diarrhoeal troubles in mankind are in many cases to be traced to bacteria that come from various kinds of diseased udders. For these reasons it is recognized everywhere that *all* animals with udder diseases should be separated from the dairy-supplying herd. It is of course not pretended that such a result is accomplished in European herds. It is an extremely difficult matter to exercise a control upon the herds of the individual farmer, but the attempt is being made by distributing information and by police regulations to accomplish the result as thoroughly as possible.

A second result has been in teaching the health authorities that there is great danger to the public health in allowing milk

to be handled by any person suffering from or even recovering from one of the contagious diseases above mentioned. Positive evidence has been found of epidemics of diphtheria, and probably, also, scarlet fever, produced by the handling of milk by a person who was just recovering from these diseases. In consequence, the best milk companies try to prevent any persons who are suffering or recovering from typhoid fever or scarlet fever, or other contagious diseases, from having anything to do with the handling of the milk. The milk is thus guarded far more carefully than it was in earlier years. It is not only prevented from coming in contact with such suspicious attendants, but it is even prevented from coming into the vicinity of such patients. Here again it must be admitted that the attempt to guard against contamination by disease germs is as yet only a partial success. The difficulty of controlling the methods on individual farms is well nigh insurmountable, but the better milk supply companies have the rule that as soon as a contagious disease appears upon any farm, the milk from that farm shall no longer be received by the milk company until the local health board have pronounced that the conditions adopted on the farm are perfectly satisfactory and safe.

With this same purpose in view, more attention has been paid in recent years to the water which is used on the farm for washing the milk vessels. The well known fact that the typhoid fever germ may live in and is frequently distributed by water, and especially by well water, has led to the conclusion that many an epidemic of typhoid fever has been produced by the fact that improper water has been used in washing the milk cans. Indeed, several epidemics of typhoid fever have been traced to such causes. Therefore, more care is being taken each year in scrutinizing the source of the water which is to be used by the dairymen. In some cities the milk companies actually make a chemical analysis of the water upon the farm before they will admit a farmer among its patrons. When a farmer desires to sell milk to these companies, the companies send inspectors who examine his farm as to its sanitary condition, and end by making an analysis of the water, and if the analysis shows the water to be impure they either insist that the farmer shall obtain a better supply, or refuse to accept his milk.

MILK SUPPLY INSTITUTIONS.

These various applications of our knowledge of dairy bacteriology to dairying, so far as concerns the general milk supply, are, at the present time, made chiefly either through the public inspector or by the formation of large milk supply companies. The supply companies are indeed more successful than the official inspectors. It is easy to understand that such companies can control the matter very much more easily than can any public authorities. Public law may make the rule that a cow with an udder disease shall not furnish milk to the public, but the individual farmer with little to hinder him can break the rule almost at will. When, however, a milk supply company makes such a rule and keeps inspectors frequently visiting the farms, the farmer knows that if he breaks the rule he will probably be discovered and lose the market for his milk. He is therefore very much more likely to follow the instructions given than when they come through public statute. The milk supply companies of the various cities in Europe are therefore adopting regulations of this sort more and more carefully each year, and as a result the character and quality of the milk furnished by these companies is improving each year. There is hardly a city of any size in Europe that does not have one or more of these large companies which furnish milk in large amount and whose milk has acquired an established reputation.

Probably the most noted of these milk establishments is one in Berlin, known as that of C. Bolle. The organization and the management of this establishment is unique. It is a large establishment, collecting and distributing about 70,000 quarts of milk daily. This means a much larger patronage than it would mean in an American city, for the people in Berlin drink comparatively little milk, and the 70,000 quarts of milk mean nearly 300,000 patrons. The establishment of C. Bolle consists of a large number of fine buildings in the midst of the city. As one visits the institution he is especially struck, not so much with the methods of handling milk as with the methods of handling men. Perhaps the first room that he enters is a large hall, where there is held weekly a religious service and where there are occasionally given fairs and entertainments of various kinds by the employes of the establishment. He learns presently that there is a school connected with the establishment, where the children of the em-

ployes obtain excellent education. He learns that a well equipped and carefully conducted kindergarten is found inside of its walls. He is taken into a room where he finds 200 or 300 children attending a singing school which is held once or twice a week. He learns that the establishment has its own system of insuring its employes in such a way that by the setting aside of a small portion of the wages weekly the employes are insured against accident and sickness, and the family insured against his death. His family is thus cared for, and poverty among the employes is prevented. He finds a well equipped library and learns that there is a branch of the Y. M. C. A. organization doing work among the men, and a somewhat similar organization doing work among the women. He learns that there is a weekly paper printed in the establishment, that a Sunday-school is carried on each week; and he even finds that the company furnishes and repairs the boots of its employes. In short, he finds inside of this establishment almost what might be called a large family of people joined together for mutual good and for mutual improvement. It is not to be wondered that the employes are extremely proud of being members of the Bolle establishment, and that the places are at a very great premium. With such an intelligent, well-cared-for lot of employes it is possible to handle the great business with ease and accuracy, and not to experience the troubles which so frequently come elsewhere from carelessness or ignorance.

So far as I am aware there are no other institutions in European cities that compare with the one described, in the extent of the organization among its employes. At the same time there are large numbers of companies in different cities whose purposes are similar to those of Bolle, namely, to furnish in large quantities a supply of the very best kind of milk to citizens of larger communities. Such institutions soon obtain a reputation which is their stock in trade. They cherish it with a great deal of care, and every attempt that appears possible is made to protect the quality of the milk which they furnish their patrons. Their methods effect every condition which may surround the milk from the very outset. In the first place, a careful selection is made in regard to the dairyman who shall furnish the milk originally. The cows are, as a rule, examined by a veterinarian before the milk is accepted by these institutions. The sanitary conditions in the dairy are looked into carefully, and suggestions for improve-

ments made. From time to time an inspection by paid officials is made in all of the dairies which furnish the milk. The institution of Bolle spends \$15,000 a year in official inspection among the dairies of its patrons.

The milk is carefully tested, both chemically and as to temperature, when it reaches the distributing factory in the city. In some cases every can of milk brought in is *tasted* by experts to determine whether there is any trouble appreciable to the tongue. The milk is commonly filtered or run through a centrifugal machine, and large quantities of milk derived from a great variety of sources are thoroughly mixed together in order to insure an almost absolutely uniform product. The greatest care is taken in sterilizing the bottles in which the milk is distributed, or the milk cans in which it is stored.

If a contagious disease occurs on a farm, the attempt is made to stop the reception of milk from the farm in question for a length of time which appears to be necessary. Some of the companies even go so far as to pay the farmer for the milk during the whole of the time in which the milk is refused at the factory because of such infectious disease, a kindness which is sometimes abused by the farmer. If an infectious disease should appear in the family of one of the employes of such an institution, the individuals of the family are not allowed to have anything more to do with the handling of the milk until complete recovery takes place. In some cases this attempt to prevent distribution of contagious diseases goes so far that if an infectious disease occurs in the family of one of the consumers of the milk, the milk is no longer delivered to the family in question from the ordinary milk-distributing cart, but a special messenger is sent from the factory to such houses, the belief being that by such means any possible danger of distributing the disease from house to house is prevented.

Most of these institutions have chemical laboratories, and some of them have bacteriological laboratories, where the character of the milk is studied and where the infectiousness of the milk, so far as its effect upon animals is concerned, can be investigated. In some of them, careful observations are being made to determine whether their milk is the cause of the distribution of tuberculosis. Up to the present time, so far as I am aware, no attempt is made to use tuberculin among the cattle for the purpose of excluding from the milk supply such animals as may react to this test.

Nearly all of these institutions make a special attempt to furnish milk of extra character for the use of young children. This is done not only by securing especially healthful cows, but also by feeding them upon what is regarded as especially healthful food, and the milk thus obtained is, either rightly or wrongly, regarded as safer for the use of children than the ordinary milk, and it naturally is sold at a greater price.

It is of course clear that the development of methods by such large institutions are sure to produce a gradual improvement in the quality of the milk. This improvement has also been stimulated by the gradual development of police regulations in the various cities. In Germany, in particular, the rules for the inspection of the ordinary milk supply have been perfected in the last dozen years, until now they are extremely rigid. The inspection of milk here is wholly in the hands of the police, and thousands of tests are made monthly of the ordinary milk distributed through the streets of Berlin. At the institution of C. Bolle the test is made before the milk-distributing carts leave the supply station, and then the carts are locked so that the milk cannot be tampered with. These tests, it is true, are mostly chemical and physical, rarely bacteriological, but the result has been that the application of the tests have little by little raised the quality of the milk from a bacteriological, as well as a chemical, standpoint, and it is found that to-day the milk supplied in these cities has a very decidedly smaller average number of bacteria than the milk supplied a few years ago, as well as a better average chemical analysis. All of these changes in the quality of the milk have been in the way of an improvement, and, if we except the fact that the milk used to-day probably is more likely to be contaminated with tubercle bacilli than it was ten years ago, we may state that the advances made in the last decade, as the direct result of the application of the bacteriological knowledge, have produced a gradual but a very decided improvement in the quality of the milk in the cities in Europe.

MILK STERILIZATION AND PASTEURIZATION.

Probably the most important change that has come over the system of dairying as the result of bacteriological knowledge has been in connection with processes of sterilization and pasteurization. The extension of the belief that milk is the cause of various contagious diseases, as well as a considerable

portion of the diarrhoeal diseases among children, has led to the custom of sterilizing milk for the purpose of killing all bacteria that may be present. Sterilizing or boiling milk was first adopted in cases of sickness, since it was found that boiled milk was more advantageous to the patient than raw milk. Its use extended to the diet of children, and in recent years more and more widely among adults, until in some places the practice of sterilizing milk for consumption is well nigh universal. In Germany it is very common. In Switzerland, well nigh universal in cities. In England it is hardly more common than in the United States. The purpose of such treatment is manifestly two-fold. It is primarily to destroy all disease germs and thus render the milk harmless from the standpoint of infection. It is, secondly, to produce a grade of milk which will keep longer than without such sterilization. The rare use of ice in Europe makes this second advantage of sterilization a more important one than with us.

As the popularity of sterilized milk has been increasing in the last ten years, naturally there has developed a greater knowledge of methods and a perfection of machinery for accomplishing the purpose. We find that the methods have differentiated themselves in three different directions, according to the amount of temperature used in bringing about the result. The first produces absolute sterilization, which kills every living bacterium that may be present in the milk. The second produces an almost complete sterilization, such as is obtained by simple boiling, while the third abandons the idea of killing all bacteria, and only endeavors to destroy the disease germs and a majority of the others. In connection with these three methods there have been invented many machines of more or less value. It is not the purpose of this article to attempt to describe these machines, although their manufacture has become a great industry in itself, and in some countries they have almost revolutionized the matter of milk distribution in cities. It is, however, necessary to refer briefly to the two extreme processes above mentioned, viz.: the complete *sterilization* and the process known as *pasteurization*.

Sterilization. — The complete sterilization consists in heating the milk to a temperature somewhat above that of boiling water, the actual temperature adopted varying slightly from about 215° (102° C.) to 221° (105° C.), or 223° (106° C.), and

the time of heating also varying quite widely. The machines devised usually receive a large number of bottles of milk, heat them to this temperature, and then close them, sealing them hermetically, while they are still inside of the apparatus, in order to avoid the chance of air contamination if the machine were opened before the sealing of the flasks takes place. Various mechanical contrivances for this purpose have been devised. Such milk is then sold as sterile and sure to contain no bacteria, and as, consequently, capable of being preserved for an indefinite length of time. Such milk may be exported, may be kept for months, and whenever it is opened it will be as fresh as the first day it is closed. The popularity of this type of sterilized milk has undoubtedly been growing quite rapidly in the few years since it has been offered to the public. People who are aware of the dangers from drinking milk are glad to be able to relieve their mind from the conception of the danger by feeling that they are drinking milk that is absolutely safe.

The results of the extension of the use of such sterilized milk are, according to the claims of the statisticians, very satisfactory. It has been found that, as the use of sterilized milk has extended, the number of deaths among children from intestinal troubles has decreased. This decrease, moreover, is undoubtedly to be traced to the milk sterilization, as is shown by a careful comparison of the amount of mortality among children living upon sterilized milk and those living upon raw milk. The following statistics will indicate this and show to what an extent the adoption of sterilization in milk is having an effect upon infant mortality. Out of each one thousand deaths that occurred in the city of Grenoble, France, in the years 1894-1897, there occurred the following number among infants:

In the year	1894	1895	1896	1897
Among children using raw milk	66	86	54	69
Among children using sterilized milk	25	42	16	27

Wherever the adoption of sterilization has occurred a somewhat similar result has been reached.

There are, however, certain disadvantages in this method of treating milk, disadvantages so great as to lead a large class of people to refuse absolutely to adopt sterilization. Firstly, the treatment of milk by such a high temperature very decidedly changes its taste and gives it the well known cooked taste, which to many people is quite disagreeable. Many

people say that they prefer to drink no milk rather than to drink milk that has been thus treated. Moreover, not infrequently the appearance of the milk is changed from a white to a brownish color, and this adds to the hesitation with which many people drink such milk. These are doubtless minor matters, since one's taste could be modified if the practice should become necessary.

Secondly, it is found that even with the very best of methods the sterilization is not absolutely sure. It is true that in the vast majority of specimens thus treated the milk is sterile and may be kept for an indefinite length of time. It is true, also, that in all cases the true disease germs are destroyed by this temperature. But it is also true that in a small number of cases the milk thus treated still retains certain bacteria spores which subsequently grow in the milk and produce very decided effects upon it so that the milk does not keep for the length of time expected. The serious matter in this connection is that the changes that are produced in the milk by these resisting germs are, as a rule, such as do not appeal to the eye, and perhaps not to the taste, so that the milk may be full of bacteria and may have its chemical character quite decidedly changed and yet be swallowed freely with the belief that it is perfectly normal. Now, while these resisting germs are not true disease germs, there are among them some which produce certain poisonous products giving rise to intestinal troubles, and it sometimes happens, therefore, or at least this is the belief of some bacteriologists, that the so-called sterilized milk may, in spite of the high heat, give rise to intestinal troubles among children that are fed upon it. The serious factor in this matter is that the eye and the taste detect no difference between such milk and milk that is absolutely sterilized.

Lastly, it appears to be pretty generally believed that milk that has been thus sterilized at high heat is somewhat less digestible and less easily assimilated than raw milk. Over this matter there has been and is still considerable dispute, but probably the balance of evidence indicates that there is a slight inferiority in the value of such milk as food.

These objections have led to the dislike of sterilized milk on the part of many, and to the adoption of the method of *pasteurization* which is at the present time gaining a firm foothold in certain localities.

Pasteurization. — Pasteurization consists in heating the milk to a temperature of about 165° or 175° (74° or 80° C.) for a short time, and then rapidly cooling it. It does not pretend to destroy the bacteria in the milk, but it does destroy, or at least renders innocuous, all of the true disease germs, and it reduces the number of bacteria very greatly. The reduction in the number of bacteria is so marked that the milk thus treated can be kept sweet for one or two days longer than milk that has not been thus treated. The advantages claimed for pasteurization are that it destroys the disease germs without producing the unpleasant taste and without producing any effect upon the milk which lowers its digestibility. Moreover, it is known by the consumer that the milk is not designed for indefinite keeping, and that it must be used fresh. It will therefore always be consumed before there has been a chance for the great development of poisonous products, which occasionally occurs in the bottles of sterilized milk which have been kept for weeks. In other words, all of the advantages for quick consumption which are obtained by sterilization are obtained by pasteurization and in addition it has advantages of its own. The fact that it does not produce a complete sterilization condemns it in the minds of most Germans, who want to do everything thoroughly if they do it at all. To those who are after practical rather than absolute results, however, the method has much to recommend it.

Pasteurization has therefore become somewhat popular in recent years. For several years the method has been used quite widely in private practice. The milk that is given to children, or milk that is used for drinking, is frequently heated to a moderate temperature and subsequently cooled. There have been invented, both in Europe and in this country, special forms of apparatus which are designed for producing this result with ease and accuracy.

In very recent times there have been developed in the large milk supply institutions methods which are designed for furnishing such pasteurized milk on a large scale. Beyond question the most highly developed of these is one in the city of Copenhagen. In this city there is one large institution which furnishes pasteurized milk to its customers in great quantities. At the present time the amount of milk thus distributed in the city is about 30,000 quarts per day, an amount equal to that of any of the other establishments in the city which furnish raw milk.

The methods adopted in this institution are unique, inasmuch as they have been developed wholly in Copenhagen, and indeed inside of the walls of this establishment. The milk, after being received, is subjected to a chemical analysis, but less attention is paid to the temperature of the milk than in the other institutions. Less attention is paid also to the matter of infectious diseases than in other institutions, it being assumed that isolated cases of infectious disease will have no influence upon the health of the people who drink the milk, since it is to be subsequently pasteurized. If there should be a widespread epidemic among the farmers, the matter would be taken into consideration, but it is not thought necessary to consider isolated cases. The milk, after being weighed, is passed through a very complicated and extremely ingenious machine which has been devised upon the premises. The description of this machine cannot be given here, but the milk passes through it in a constant stream, and during the passage it is heated to a temperature of 175° (80° C.), kept at that temperature for a moment, and is then cooled rapidly to a low temperature, and when it leaves the apparatus it is quite cool. It is then run rapidly into carefully sterilized bottles, sealed at once, and stamped with the company's stamp, and is distributed over the city in ordinary milk carts. In this institution the greatest care is taken in washing and in sterilizing the bottles, the bottles used for this purpose being not simply sterilized by steam, as in most institutions, but in an enormous iron chamber which is hermetically sealed and in which steam is introduced at a high pressure, so as to produce a very high temperature. Any surplus milk which the company receives is passed through a separator and the cream used for making butter, the rest being sold as skim-milk. The institution has a chemical and a bacteriological laboratory that keeps a careful watch of the efficiency of the pasteurizing apparatus. The whole success of this institution is in the ingenuity of the pasteurizing apparatus, which is capable of pasteurizing milk at the rate of about 2,000 quarts per hour, and can run continuously without trouble. It has been objected that such machines which run continuously and only heat the milk to 175° (80° C.) for a moment do not do their work thoroughly. This objection depends entirely upon the object in view. If the design is to destroy the bacteria wholly, or in large measure, the objection is well grounded. But if the object is simply to remove the dangers of distributing disease by

means of the food supply, the machine accomplishes its purpose, for a heat of 175° (80° C.) continued a minute probably renders innocuous all the disease germs likely to be in milk.

The surprising fact is that this Denmark company is able to furnish its milk to its customers at the same price that the ordinary companies in the city furnish raw milk and can do this at a profit probably equal to that of the other companies. The explanation appears to be in several circumstances, the chief of which is that they do not need to demand that the milk which is sent to them shall be kept so cool. It is cheaper to produce heat than to produce cold, and whereas the ordinary milk dealers in Copenhagen insist that the milk which they receive shall not be at a temperature of above 39° (4° C.), the pasteurizing institution receives it up to 50° (10° C.). The difference in expense between keeping the milk at 39° (4° C.) and 50° (10° C.) is almost sufficient to pay for the expense of pasteurizing milk after it reaches the factory. Heat is cheaper than cold. There are other lines in which a saving is produced, also, and the result is that pasteurized milk can be bought in Copenhagen at the same price as ordinary milk. The purchaser can be confident that he is obtaining milk which offers no danger, either as a source of tuberculosis or any other contagious disease, which has no taste other than that present in normal milk, and which is as digestible and as easily assimilated as raw milk. It is the most successful application of pasteurizing on a large scale that has been adopted anywhere in the world, and furnishes the public with this food product in the safest and the most satisfactory condition.

So far as I am aware, the method of furnishing pasteurized milk in large quantities has not been adopted to any great extent in other European cities. There are some other places where smaller institutions have been developed and where such pasteurized milk can be bought, but as a rule the purchasers in European cities must buy either raw milk or sterilized milk.

This whole development of pasteurized and sterilized milk is apparently in its infancy. The belief that milk is frequently a source of the distribution of disease is so rapidly growing that the demand for some method of treating milk before its distribution is becoming louder each year. In some European countries children in the schools are taught the danger of drinking raw milk. The physicians from the medical schools are everywhere taught of this danger and, as the result of these

two facts, the demand for sterilization and pasteurization is absolutely sure to grow in the future. It might be well for our own dairymen in the United States to take a lesson from these facts and to be prepared in the near future to furnish our own public with a similar grade of pasteurized and sterilized milk. For it is pretty certain that a similar demand is to arise in this country. If some of our milk companies would establish as successful a method of pasteurizing milk as has been adopted in Copenhagen, and should use the proper means of introducing it into our cities, there is no question that the scheme would meet with very great success and would undoubtedly yield large financial returns to its originators. Although the people of this country are not so alarmed over the dangers from milk as are the Europeans, nevertheless we drink much more milk than they do in Europe, and if the consumers of milk could be promised absolute surety against disease, and at the same time be furnished milk at the same price as the ordinary milk, there is no question that the method would be exceedingly popular from the very start.

II. BACTERIOLOGY IN BUTTER-MAKING IN EUROPEAN DAIRIES.

The influence of bacteriology upon methods of butter-making has not been so widely extended as has its influence upon matters connected with milk supply. If we look over the various countries in Europe we shall find that the southern Continental nations and England have, up to the present time, been almost unaffected in their methods of butter-making by the facts connected with the discoveries of bacteriology. On the other hand, the northern nations have been more influenced thereby, and in northern Germany, and more especially in Denmark, the methods of butter-making have been almost completely changed within the last ten years under the influence of bacteriological discoveries. In the butter-making communities in northern Europe, the whole process of handling the milk from the time that it leaves the cow until the time the butter is ready for market has been entirely revolutionized. The methods adopted there are only somewhat slowly extending into other countries, but apparently it is a matter of a few years only when similar methods will be adopted everywhere that there is an attempt made to obtain a high quality of butter.

As is well known, the study of bacteriology has turned the attention of butter-makers primarily to the process of cream ripening. It has shown them that in the proper ripening of the cream lies the secret of obtaining the best quality of butter. It has shown them that under usual conditions this cream ripening is largely a matter of chance. It has proved that the quality of the product is in considerable degree dependent upon the particular kind of bacteria which may ripen the cream, and has shown that by natural processes the butter-maker is unable to be sure of obtaining the desirable species. These facts are well known, but the practical application of them has not been very widely extended in any European country except Denmark and northern Germany.

PURE CULTURES IN DENMARK.

It was in Denmark, however, that the practical application of this subject was first made. The reputation of Danish butter is well known. It stands, without question, at the head of all types of European butter. Danish butter is exported in very large quantities, is sold at the highest prices in foreign markets. This reputation has always adhered to the butter of Denmark, and within the last ten years, since the application of bacteriological methods of butter-making, the reputation of the butter has not fallen, but has increased.

It was in Denmark that the first attempt was made to use what are now known as pure cultures for cream ripening. Under the influence of the Danish bacteriologist, Prof. Storch, there was introduced into the Danish creameries a method of ripening cream through the agency of artificial bacteria cultures. The method was moderately successful and gradually extended. From Denmark it was adopted in the dairying countries in northern Germany, and from these places it has in isolated instances extended to other countries. But even to the present day it is only in these two countries where the use of this method has been adopted in anything more than exceptional instances. In other countries, pure cultures are used only when the butter-maker has trouble with his butter. In Denmark, however, the use of pure cultures has become very common. It is stated that *over 95 per cent.* of the butter made in this great butter-making country at the present time is made by the agency of artificial cultures used in cream ripening. This percentage is surprising, and conveys a very great

lesson. Danish butter-makers stand at the head of the profession for the world. Danish butter commands the highest price and has the highest reputation of all butters. The Danes themselves adopt with practical uniformity the use of pure cultures, and the undoubted inference to be drawn from this is that the use of pure cultures in cream ripening is not only practical, but it results in uniform advantage.

The pure cultures that are used in the different dairies in Denmark, however, are not all alike. There are several of them for sale in dairy districts, and different cultures contain quite different species of bacteria. Most of them are really pure cultures, that is, masses of a single species of bacteria. Some of them, however, are mixtures of different bacteria, and one at least contains no less than ten or a dozen different species of bacteria mixed together. Such a mixture is not an artificial one, but is obtained simply from some natural starter. Doubtless in the action of such a mixture some of the bacteria have no influence at all in the process of cream ripening.

The actual operations in the Danish creamery may be interesting to describe in some detail, inasmuch as they illustrate so well how all of the lessons from bacteriology are brought together and applied. A typical Danish creamery, then, may be described somewhat as follows: The milk is brought to the creamery in large cans. As soon as it reaches the creamery it is placed in a large receiving vessel and warmed to a moderate temperature, about 25°C . From this receiving vessel it passes directly into a separator, and the skim-milk and the cream are received in separate compartments. The skim-milk is immediately pumped from the receiving vessel into a large receptacle surrounded by steam coils, through which steam is passing constantly. In this receptacle the skim-milk is heated to a temperature of 175° (80°C .), the milk in the receptacle being kept constantly at this temperature. As it is being constantly pumped in it is also being constantly drawn out into the milk cans of the farmer, who takes this heated milk and carries it back to his farm for use in feeding calves and pigs. The skim-milk is in this way pasteurized for the purpose of neutralizing the danger of distributing tuberculosis.

The cream which comes from the separator is elevated by mechanical contrivances into a smaller receptacle, which is also surrounded by steam coils, and in this receptacle the cream is also heated to a temperature of about 175° (80°C .),

or somewhat less, remaining at this temperature for a short time. This pasteurizing not only destroys the tubercle bacilli and all other disease germs which might be distributed through the butter, but it also destroys the majority of the lactic bacteria. After the pasteurization the cream is cooled and received in large ripening vats.

In the meantime the dairyman has prepared his starter. This is prepared in milk that has been sterilized by high heat, and which has been inoculated with a sufficient quantity of the commercial pure culture, which the dairyman buys in small quantities at short intervals. The milk thus inoculated is allowed to stand at a warm temperature for a day or more, until it becomes properly acid and slightly curdled, and this starter is added to the pasteurized cream after it has been cooled. The rest of the process is not especially different from that in other dairies. The ripening continues about a day and the churning and working are as usual, although the Danish butter-maker is more frequently inclined to use his hands in working the butter rather than a mechanical butter-worker. The butter may or may not be salted, but if it is salted the amount of salt is extremely slight, not a quarter as much as is used in the ordinary creamery in our own communities. By this method it will be seen that pasteurization has extended almost universally in Denmark, not only to the skim-milk, but also to the cream. As a result, there is an equally wide use of artificial starters. The details of the process in different creameries, of course, differ. In some, the whole milk is pasteurized before it is run through the separator instead of after. But in practically all, the process of pasteurization is an integral part of the butter-making.

The results of this method of the use of pure cultures in Denmark are, of course, satisfactory or the method would not be so universally used. It is somewhat more expensive than to make the butter without the use of pasteurization and pure cultures, and we may be sure that if the results were not satisfactory the process would not have been adopted in over ninety-five per cent. of the creameries.

DANISH DAIRYMAN'S ASSOCIATION.

The Danes have a somewhat curious association of butter-makers, designed for aiding the butter-making communities and determining so far as possible the best methods and the

results of methods. This association comprises some 700 of the largest creameries in Denmark, and it is supported by government appropriation of about \$8,000 yearly. At Copenhagen there is a central committee whose duty it is to put into operation the practical details of testing butter. At short intervals this committee sends word to a number of the creameries to forward to Copenhagen immediately a sample tub of butter from their creamery. There is no regular order taken in choosing the creameries, and the butter-makers have no previous notice as to when they are to be called to send butter. As a result, there is no possibility that a creamery can prepare a special lot of butter for this exhibit. This butter is brought to Copenhagen, placed in a cold room in specially prepared vessels in such a way that it is impossible for the scorer to determine the mark on the butter and therefore to determine from what creamery it comes. Apprizers score the butter after it has stood in this cold room for a couple of days. Care is taken that not a large enough number of samples are sent at once to make the scoring too difficult. The apprizers in each case consist of six men drawn from a list of about forty butter exporters. Weekly records of the scoring are published by number only, each creamery thus knowing the scoring of its own butter, but not of its rivals. After the scoring has been made, the marks on the butter are examined and a record is kept of the scoring, together with all of the data in regard to the manufacture of each sample of butter. The data thus kept include everything in connection with the method of working, of salting, the use of pure cultures, and the particular kind of pure cultures that are used. By this method of testing butter this dairy association has been obtaining a large amount of valuable information as to the practical result of methods in use. They have here means of determining, not by isolated scoring, but by a long-continued series of observations, the value of pure culture methods as compared with methods without pure cultures, the value of the different brands of pure cultures, and all other details which may be collected.

From the record of this association it is therefore possible to determine with a considerable degree of accuracy what has been the actual result of the use of pure cultures in Denmark. Apparently the results are as follows: Butter made with pure cultures is almost always better than that made by the older method. While this is not always the case, and while it is true

that some samples of butter made without pure cultures rank very high, there is no uniformity in regard to the grade of the other types of butter, while the butter made by pure cultures is of a uniform high grade. There has been, since the introduction of pure cultures, a noticeable and an almost universal improvement in the grade of Danish butter in general. Whether this means that the best grade of Danish butter has been improved, it is not very easy to determine, but beyond question the butter in Denmark to-day grades higher and is of a superior quality to the butter of ten years ago, before the use of pure cultures was adopted. It has been found, thus far, difficult or impossible to determine any very great difference between the different kinds of pure cultures that have been used in the different creameries. At one time one of the brands of pure cultures will score higher and at another time another brand will score higher, a result thought to be due to different methods of use. With the fluctuating results that have been obtained hitherto, no one of the types of pure cultures stands so prominently ahead of the others as to claim any special merit.

While the grade of the butter has been uniformly increased it has thus become something of a question whether the keeping property of the butter has been improved or diminished. Most dealers say that the butter keeps as well as ever, but some of the English dealers insist that the butter in recent years deteriorates more quickly than it used to in earlier years. This is thought to be due to the fact that the general grade of butter sent from Denmark is at the outset higher than it was a few years ago, and, as is well known, the highest grade butter deteriorates more quickly under the best of circumstances than butter of an inferior quality. The lack of keeping power complained of by certain dealers is, according to the belief of the Danish experts, due rather to the uniformly high grade of the butter than to the fact that the butter actually deteriorates more rapidly than in earlier years.

The butter that is produced by means of these pure cultures is extremely uniform and there is very little difference between the flavor of the butter produced by the different brands of pure cultures. In general, one accustomed to American butter will find that the flavor of the Danish butter is rather flat. The taste of the European butter consumer demands something different from the taste of our own consumers. In Eng-

land and elsewhere in Europe there is desired a butter with the slightest possible flavor and with the smallest amount of salt, or, indeed, unsalted. Such butter would not meet the taste of our consumers. In the United States there is desired a butter with more flavor, and the butter which we are especially desirous of obtaining here conversely is thought by Europeans to be too strong and to savor too much of decay. These differences in the quality of the butter are simple matters of taste, but it is necessary for our American butter-makers, in comparing Danish methods with our own, to take into consideration the fact that the Danish butter-makers make a product somewhat different from our own, and one in which there is not so high a flavor.

BACTERIA IN OLEOMARGARINE.

Closely associated with the application of bacteriology to butter-making is its application to the preparation of artificial butter and various oleomargarine products. This subject, however, may be passed over with only a word. In certain European countries, especially in Holland, oleomargarine is made in very large quantities. The largest factories in the world are located in Rotterdam. In these factories the use of pure cultures has for some time been adopted with almost absolute uniformity. The shrewd business men who manage these factories have thoroughly learned that if they wish to obtain in their products a flavor imitating that of butter they are obliged to use bacteria to give them this flavor. They therefore buy the artificial pure cultures and inoculate them into large quantities of pasteurized milk in essentially the same way that the butter-maker inoculates them in his cream. They allow this milk to stand in a warm place for a length of time, which will produce the proper amount of souring, and then this ripened milk is mixed with the fats and the mixed oils made into margarine products. The result is that a flavor of butter which is, of course, derived from bacteriological products of the souring milk, is imparted to the margarine. All of the better grades of artificial butter are made in this way. The margarine factories use various kinds of pure cultures and experiment upon them with a good deal more care and know much more about their use than do the butter-makers. Butter-makers make comparatively small quantities of butter, while oleomargarine factories make their

product in very large quantities, and their market is much more dependent upon the grade of their product than is the market for butter. Some of these oleo factories have their own bacteriological laboratories, where experiments are going on constantly and where they can obtain their own pure cultures and make use of the very best results of the most recent advances in bacteriology. The wide application of bacteria in the manufacture of oleomargarine products should be a lesson to the butter-maker.

III. BACTERIOLOGY IN CHEESE-MAKING IN EUROPE.

During the last few years a considerable majority of the students of dairy bacteriology have turned their attention from the study of milk and butter to the study of cheese. The reason for this is a practical one. It has been recognized for some time that the character of the different varieties of cheese is due, at least in considerable degree, to the peculiar kinds of fermentation which take place in the cheese during the ripening. In the cheeses which are popular in the markets of Europe, the variety of flavor is very great. One who goes through the markets in the different countries of the Continent is especially struck with the extremely great differences between the different kinds of cheese, and the great number of varieties which are popular in different localities. If these differences are due to types of fermentation it would be plainly a matter of great practical value to dairying if there could be discovered some strictly scientific method of producing the different varieties. The bacteriologist who shall discover the means of applying in a practical way to cheese making the facts which have been discovered in connection with bacteriology will not only gain a great reputation for himself, but will undoubtedly reap a large amount of financial profit at the same time.

The problems connected with cheese offer, therefore, a very fertile field for research. In the application of bacteriology to butter-making it has been thought that perhaps no further great improvement can be made now that we have actually learned to control the flavor of butter, at least to a considerable degree, by the use of pure cultures. But in the operation of cheese-making there are almost limitless possibilities, because

of the many varieties which each country demands. If it were possible to find some means of making the popular cheeses in other localities than those where they are ordinarily made, it is plain that a great impetus could be given to dairying. If Edam cheeses could be manufactured equally well in all countries where they are in demand, if Swiss cheeses could be made with equal ease and equal surety outside of Switzerland, it is of course plain that the whole condition of the dairy industry would be changed. For these various reasons it is that in the last few years bacteriologists have ceased to pay much attention to the problem of the relation of bacteria to butter, and have given a correspondingly great amount of study to the problem of cheese-making.

The problem, however, has proved to be an extremely difficult one. Its very complexity has made the subject very difficult to reach. There is no question that the flavor of the cheese is developed during the period of ripening, which occurs after the cheese is made. But in that ripening there are a variety of changes that take place. The changes in the chemical nature of the cheese are very profound, and while these are in part due to bacteria they are apparently also in part due to certain unorganized ferments which are present in the milk. Moreover, the growth of bacteria in such cheeses is irregular and presents problems which have hitherto been largely insoluble. That the cheese flavor is due to bacteria or to moulds is everywhere agreed.

Bacteriologists are as yet unable to agree as to what kind of bacteria are most intimately concerned in the ripening process. While there are some who bring forward an abundance of evidence that the *lactic* organisms are those primarily concerned in the process of cheese ripening, there are others who bring forward also a large amount of good evidence that it is not the lactic organisms, but rather bacteria, which give rise to an alkaline reaction and which have power to digest proteids; while beyond doubt some types of cheese owe their peculiar character to moulds, rather than bacteria. It is of course clear that when such a simple, primary matter as this cannot be settled with any degree of unanimity, we cannot expect to find any very considerable amount of practical results arising from bacteriological work. Until a more thorough knowledge of the whole process is obtained we can expect to find very few practical applications of bacteriology in cheese-making.

At the same time, there have been some improvements which have taken place in cheese manufacture as the result of bacteriological knowledge. It has been shown beyond peradventure that a majority of the "faults" which arise in cheese and which make their appearance during ripening, are due to the growth in the cheese of certain malign kinds of bacteria, or sometimes due to the undue growth of bacteria which, under different conditions, would produce no injurious effect. The "faults" which arise in the cheese during the ripening are quite varied and need not be enumerated. They concern the appearance, the consistency, the taste, the odor, and the healthfulness of the cheese, and while it would be premature to say that they are all due to improper fermentations, it is now known beyond question that at least a majority of them may be attributed to such causes. Moreover it is known that in many cases the sources of such troublesome fermentations lie in the fact that there has been used in the manufacture of the cheese, milk which has become unduly contaminated with malign bacteria. There have been enough instances discovered where a troublesome "fault" in the cheese has been traced to the milk from a single dairy to indicate that in the successful method of cheese-making of the future it will be necessary to have a more careful control over the kinds of milk used in the manufacture of cheese.

It has been suggested that perhaps it may be necessary to use the same process of pasteurization for the purpose of getting rid of such possible errors as is used in the butter manufactories. The pasteurization of the milk for cheese-making has as yet, however, not been applied in any cheese factory. A few experiments have been made by bacteriologists to determine whether it is possible to pasteurize the milk without injury to its curdling powers under the influence of rennet. Of course, if such were not the fact, it would follow that pasteurization could never be used with success in cheese-making. These tentative experiments have indicated that when the time comes that bacteriologists can offer promise of a great surety in the results, pasteurization of the milk for cheese-making is perfectly feasible, for when it is properly conducted the milk will be curdled by the rennet in a perfectly normal fashion.

Almost the only practical application of bacteriology in general cheese-making which has been introduced as yet has been in the development and the application of a so-called

"fermentation test" designed for the purpose of enabling the cheese-maker to exclude from his cheeses any milk which is likely to produce trouble. Its application is extremely simple, and there have already been devised and put upon the market forms of apparatus which make it convenient to use in ordinary cheese factories. It consists simply in testing separately samples of milk from each patron. The essence of the process is merely this: A small sample of the ordinary milk is put in a special vessel by itself, and is then subjected to a moderately warm temperature and carefully watched. If the milk is found to curdle in a proper time in a normal fashion it is regarded as perfectly safe to use; but if the milk becomes full of gas bubbles in the curdling, if the nose or the tongue detects any specially unpleasant or unusual qualities, it is inferred that the milk is filled with bacteria that will be deleterious to the process of cheese-making. When this occurs the milk from the sources from which the sample is taken is not allowed to be mixed with the ordinary milk for the purpose of making the cheese. This fermentation test is not used very widely. As a rule cheese is made to-day practically as it was fifteen years ago, before any knowledge of bacteriology was obtained. But cheese-makers have learned that this fermentation test may be used at time of trouble and may be used as a means of discriminating milk that can be safely put into cheeses from that which it is not safe to use in this way. The practical difficulty in the way of the test is, of course, that the cheese-maker may not discover until weeks after the cheeses are made that they are likely to develop certain undesirable faults, and by this time the fermentation test is of comparatively little use. The original source of error has very likely disappeared, and the application of the fermentation test after the discovery that the cheeses are liable to "faults" is too late to be of much use. Nevertheless the fermentation test has been in some cases found to be of practical value.

The success of the use of pure cultures in improving the quality of butter, and the manifestly close relation between the form of fermentation in ripening cheese, and the character of the cheese, suggests, of course, a very great possibility of the application of pure cultures to the process of cheese-making. If it is true that the flavors of different kinds of cheeses are due to different species of bacteria or moulds, it ought to be possible to use pure cultures of the proper species in such a way as to give rise to perfect uniformity in the results, and to make it

possible to produce in any part of the globe any particular kind of cheese. It is along this line that bacteriologists are working to-day, hoping that by an extension of their experiments they will learn what kind of pure cultures can be used in cheese-making to give the most desirable results. Up to the present time, however, no practical results in this line of work have been reached. There is, it is true, one European bacteriologist who has put upon the market a pure culture of bacteria for cheese-making, making great claims for it, as giving rise to a very high grade of cheese with uniform results. It has not been as yet used to any very great extent, and, certainly, has as yet no very great reputation. There is another who has succeeded in making fine cheeses by the use of certain species of moulds. Beyond this, while other bacteriologists have species of bacteria which in their laboratory experiments have produced very desirable results, and have given rise to cheese with flavors that appear to be normal and uniform, the application of the method of the artificial use of bacteria in cheese-making has scarcely extended beyond laboratory experiments, and in practical cheese-making is as yet almost unknown.

SLIMY WHEY CHEESE OF HOLLAND.

There is, however, in Holland a practical application of bacteriology to cheese-making which has been derived not from laboratory experimentation, but rather from dairy practice. In the manufacture of the common Holland cheeses, of which the Edam cheese is best known to us, the ordinary method is to make the milk from a single day's milking into one or more small cheeses and to allow these cheeses to ripen under perfectly natural processes. It takes, however, a number of weeks to produce the ripening of such cheeses, and they are not ready for market for about six weeks. Moreover, there is no absolute uniformity of results.

There has been introduced into Holland a method of hastening this ripening process and producing a greater uniformity of result by the use of what is known as "slimy whey." This slimy whey is nothing more than a milk culture of bacteria, and it is carried by the cheese-maker from day to day as a butter-maker keeps his starter. A certain quantity of the material is added to the milk which is to be made into the cheese.

A study of this slimy whey shows that it is a culture of a number of varieties of bacteria and yeasts, and that prominent among them is a certain micrococcus which has the power of rendering the milk very slimy. When this organism grows in milk alone its effect is not very great, and it produces no slime. When, however, it grows in company with yeasts which consume the dissolved oxygen the milk becomes slimy. Although there may be several organisms together in this starter the slimy micrococcus appears to the primary one, for all instances of good slimy whey which are used in cheese-making contain this organism. In the last few years the use of this slimy whey in Holland cheese-making has increased until at the present time something like one-third of the cheese which is made in Holland is made by means of this artificial starter.

The results of its use are both favorable and unfavorable. In the first place, the ripening is hastened and the cheese is ripened considerably sooner than is cheese which is ripened without such a starter. It is ready for market in four weeks instead of six. In the second place, the ripening is more uniform, and the farmer that uses the starter is more sure of getting desirable results than the farmer who makes his cheese without it. These two factors, of course, are very desirable ones. But, on the other hand, the character of the cheese is somewhat different from that of the natural cheese, its consistency varies slightly so that the expert can determine at a glance whether the cheese has been ripened with the slimy whey or not. Again, the character of the ripening is thought to be slightly inferior, the flavor obtained not being equal to that of the best cheeses obtained by a natural method; and, lastly, the keeping quality of the cheese flavor appears to be somewhat less than that of natural cheese. The buyers who wish cheese for exportation buy almost wholly the cheese made by natural processes, while cheeses that are bought for immediate sale and immediate use are more likely to be those made by the artificial starter. The Edam cheeses that we obtain in this country are, therefore, nearly all of them made by the natural process. In the use of this slimy whey the farmer is obliged to renew his stock culture frequently, for his starter runs out in the course of time. On some farms, indeed, it is found impossible to keep these starters pure for more than a short time, and they must be constantly renewed, while on others, for

reasons yet unknown, they can be kept for week after week without difficulty.

There is little question that if the cheese manufacturing in Holland was carried on in larger factories this process of the use of artificial starters would be developed much more rapidly and more successfully than it has been. The majority of Holland cheeses are made in individual farms, and a farm in Holland is a very small tract of land. Such a farm will frequently make only one of these small cheeses a day; if they make three it is exceptional. Of course, some larger farms will make more. But where the cheese is made in such small quantities there is no special incentive and no opportunity for the development and application of new methods by experiment. There have in the last few years been started some cheese factories where a larger amount of milk is received daily from many farms and where these Holland cheeses are made in large quantities. Up to the present time, however, the cheeses thus made are decidedly inferior to those made on the farm, a fact that is in considerable measure due to the use of the same methods that have given a bad reputation to American cheese. Instead of using whole milk, skim milk or half skim milk is used, and the quality of the cheese is in consequence deteriorated. It is certainly within the region of probability that these larger factories in the future, through the assistance of the experiment stations that are working upon the subject of slimy whey, will develop this method and obtain more valuable applications. But even at present the use of slimy whey is adopted on one-third of the cheese-making farms, and its use is apparently extending because of the greater rapidity of ripening, and the greater uniformity which it brings.

Except in these few directions bacteriology has as yet played no part in practical cheese-making. It is the confident belief of bacteriologists that there is a greater future for the application of their results in this direction than in any other, and they are convinced that a few years will see the use of pure cultures in cheese-making developed to an extent much greater than it has been yet developed in butter-making. Up to the present time, however, the cheese-makers say that bacteriology is very interesting, but it has given them almost nothing that is practical for their use.

IV. SUMMARY OF MORE IMPORTANT APPLICATION OF DAIRY BACTERIOLOGY IN EUROPE.

The following is a summary of the statements above regarding the more important practical applications of bacteriology to dairying in Europe:

1. A knowledge of the action of bacteria upon milk has led to a very careful guarding of milk from contamination. This has been directed first to the cow, second to the conditions in the cow stall, third to the cleaning of the milk vessels, and fourth to the methods of handling the milk.

2. The demonstration of the agency of milk in distributing disease has led to the taking of great pains to prevent the milk from coming in the vicinity of disease germs. This has resulted in (1) the attempt to exclude all persons, who have contact with contagious diseases, from any participation in handling the milk; (2) greater care in regard to the water used in the dairy; and (3) the attempt to exclude from the dairy herd all animals suffering from any sort of udder disease.

3. Proper regulations can be better enforced by large business firms than by public statute, and partly as a result of this, the milk supply of the large cities is passing into the hands of a few large firms.

4. As the public has learned how disease is distributed by milk the demand for sterilized milk has grown until it can be purchased in most cities from the ordinary milk men. The dislike of the taste of sterilized milk and the belief that sterilizing makes it somewhat less easily digested have led to the adoption of the process of pasteurizing, though it is rather slow in coming into use.

5. The use of bacteria cultures for cream ripening in the process of butter-making is confined chiefly to Denmark and North Germany. In Denmark over ninety-five per cent. of the butter is made by the use of artificial pure cultures of bacteria inoculated into pasteurized cream. The results have been highly satisfactory to the Danish butter-makers. Oleomargarine is largely made by the use of pure cultures.

6. Up to the present no important practical applications of bacteriological knowledge have been made in the process of cheese-making. The only instance in practice where bacteria are artificially inoculated into milk to produce cheese ripening is in the use of "slimy whey" in the making of Holland cheeses.

TUBERCULOUS COWS, AND THE USE OF THEIR MILK IN FEEDING CALVES.

BY C. S. PHELPS.

In October, 1896, arrangements were made with the Connecticut State Cattle Commission by which four condemned Devon cows were placed at the disposal of the Station for the purpose of making some observations and experiments on tuberculosis. The herd from which the animals came was officially tested with tuberculin by the Cattle Commissioners in March, 1896, and several of the animals in the herd were condemned and slaughtered. At that time the four animals, which were later taken for experiment, failed to respond (see page 101.) These were officially tagged as free from the disease, and were numbered 1337, 1341, 1343, and 1344.

In October, 1896, the herd was again tested with tuberculin by the same commissioners, and the four cows just referred to responded to the test (see page 101), and were shortly afterward placed at the disposal of the Station, and have been kept in quarantine since that time.

The appearance of the disease in animals which seven months before were pronounced sound may, perhaps, be accounted for in one of three ways. First: The disease may have been present at the time of the first test, and, through failure on the part of the tuberculin to react, its presence was not revealed. Second: At the time of the first test the germs may have but recently found lodgment in the animals. In this case the disease might have been so little developed as not to cause a response to the test. Third: The disease germs may have been acquired by these cows after the first test was made, owing to insufficient care having been used in disinfecting the stables.

These particular animals were chosen for experiment, because there was good reason to believe that the disease was present in its earlier stages. One object in view was to study the effect of the milk of slightly diseased cows when fed to healthy calves, and also the relative danger from the spread of the disease by association with diseased animals.

The following table gives the temperatures in the two tests made before the cows came to the Station. The numbers for the cows which were used in these earlier tests have been retained by the Station:

TABLE 1.

*Tuberculin tests made with cows prior to their arrival at the Station.**

NUMBER OF COW.	BEFORE INJECTION.		AFTER INJECTION.				
	8 P. M.	10 P. M.	6 A. M.	8 A. M.	10 A. M.	12 M.	2 P. M.
<i>Test made March 14-15, 1896.</i>							
1337,	102.2	102.8	102.3	102.6	103.0	102.4	102.4
1341,	101.1	101.3	101.6	102.2	102.2	102.4	102.0
1343,	101.0	101.6	101.8	101.8	102.1	102.1	102.2
1344,	101.0	101.5	100.7	101.6	101.4	102.0	101.4
<i>Test made October 26-27, 1896.</i>							
1337,	101.3	101.4	100.6	101.6	103.0	104.4	104.8
1341,	101.6	101.4	100.8	101.7	102.4	104.4	105.6
1343,	102.0	101.7	99.6	101.6	102.8	104.4	105.0
1344,	101.8	101.1	102.0	102.0	105.0	105.8	105.6

Care of the cows, and tuberculin tests after they were taken in charge by the Station. — When the cows were brought to the Station they were placed in a high, light, and airy stable, affording about 1,500 cubic feet of air space per cow, although later several calves occupied the same stables with the cows. The Station barn is located about eighty rods from the College barn, and the tuberculous animals have been kept separate from any other cattle. Adjoining the stables is a yard about one-half acre in area, where the animals can exercise. In mild weather they have occupied the yard most of the day. No special treatment for the disease has been attempted, but good care and feed have been afforded at all times. Plans were made whereby the animals could be subjected to the tuberculin test from time to time. These tests were, in most cases, made by the College veterinarian.

*Through the courtesy of the former Secretary of the State Cattle Commission we are able to publish the temperatures obtained in the tuberculin tests made prior to the arrival of the cows at the Station. These tests were made by Dr. L. J. Storrs.

The first test after the cows reached the Station was made by the College veterinarian, Dr. George A. Waterman, January 26-27, 1897. This was three months after the animals were condemned by the Cattle Commissioners. All four of the cows responded clearly to the test. In addition to the necessary rise of temperature (two degrees above the maximum before injection), to indicate the presence of the disease, cow No. 1337 showed a roughness of the hair at 9.30 A. M., the 27th, and Nos. 1341, 1343, and 1344 each showed a decided chill between 9.30 A. M. and 3 P. M. The next two tuberculin tests were made by the same veterinarian. Three months later, April 26th-27th, all four of the cows were injected. At that time cows Nos. 1341 and 1344 responded to the test, while the other two cows showed no apparent results. None of the cows manifested any signs of chill. The next test was made about four months later, July 30th-31st. At that time none of the cows gave an appreciable rise of temperature, nor did they manifest any physical symptoms, such as chilling or roughness of the hair. Late in September it was thought desirable to repeat the test, and as the College was temporarily without a veterinarian, the services of Dr. L. J. Storrs were engaged. No response either in rise of temperature or physical symptoms was observed.

The tuberculin tests which were made in December, 1897, April, 1898, and December, 1898, were conducted by Dr. N. S. Mayo, the present College veterinarian. In these tests the temperatures before injection were taken every three hours throughout the day, but only the maxima and averages for the day are given in the table. In the test made December 17-18, 1897, cow No. 1344 showed a marked rise of temperature, while the other three showed no response. In the test made April 11-12, 1898, cow No. 1343 responded, while the other three cows did not. Cow No. 1344 showed a slight rise of temperature at 4, 6, and 8 P. M., the day after injection, but she was observed to be in heat at this time, a condition which would doubtless account for slight abnormal temperatures.

TABLE 2.

Tuberculin tests of tuberculous cows, and of calves which were fed their milk.

DATE OF TEST AND NUMBER OF ANIMAL.	BEFORE INJECTION.		AFTER INJECTION.							
			6 A. M.	8 A. M.	10 A. M.	12 M.	2 P. M.	4 P. M.	6 P. M.	8 P. M.
<i>Jan. 26-27,</i> <i>1897.</i>	5 P. M.	9 P. M.								
1337, -	101.0	101.2	101.5	102.1	104.0	105.2	106.1	—	104.8	—
1341, -	102.2	101.5	102.1	102.5	103.6	102.6	103.2	104.9	106.1	—
1343, -	100.9	100.3	101.4	102.0	102.9	105.1	106.2	—	105.0	—
1344, -	100.6	100.1	101.2	101.6	103.0	105.0	106.9	—	105.6	—
A (calf), -	102.0	102.0	101.5	101.1	101.4	101.6	101.6	—	102.2	—
<i>March 3-4.</i>	4 P. M.	9 P. M.								
B (calf), -	102.7	103.4	102.1	102.6	102.2	101.5	101.7	—	—	—
<i>Mar. 29-30</i>	5 P. M.	9 P. M.								
A (calf), -	102.4	102.6	102.4	102.0	101.7	101.9	102.4	—	—	—
<i>Apr. 26-27.</i>	5 P. M.	9 P. M.								
1337, -	103.7	102.0	102.4	102.2	102.0	102.2	102.0	—	—	—
1341, -	102.8	101.5	102.6	103.7	105.2	106.0	105.8	—	—	—
1343, -	102.0	101.6	102.0	102.0	102.2	102.0	101.8	—	—	—
1344, -	101.6	101.0	102.5	103.4	103.8	103.8	102.8	—	—	—
<i>July 30-31.</i>	5 P. M.	11 P. M.								
1337, -	101.8	101.3	102.2	102.0	102.2	102.1	102.2	101.3	102.4	102.1
1341, -	101.6	101.0	102.5	102.8	101.9	101.8	101.5	101.2	101.3	101.0
1343, -	101.8	101.0	102.8	102.7	102.1	102.2	102.0	101.8	101.4	101.4
1344, -	101.1	100.6	102.1	102.4	101.7	102.0	102.0	102.0	102.0	101.0
A (calf), -	102.5	101.8	101.8	101.8	101.4	102.0	101.8	—	—	—
B (calf), -	101.8	101.9	101.2	101.4	101.6	101.6	101.9	—	—	—
C (calf), -	103.0	102.0	101.8	101.5	101.7	101.8	102.4	—	—	—
<i>Sept. 27-28.</i>	8 P. M.	10 P. M.								
1337, -	—	101.8	102.0	102.1	101.9	101.6	101.6	—	—	—
1341, -	—	101.5	101.3	101.2	101.5	102.0	101.8	—	—	—
1343, -	—	101.7	101.5	101.6	101.5	101.3	101.5	—	—	—
1344, -	—	101.0	101.1	101.4	101.2	101.2	101.1	—	—	—
A (calf), -	102.6	101.6	101.6	101.4	101.7	101.8	102.0	—	—	—
B (calf), -	102.3	101.7	101.7	101.3	101.0	101.2	101.5	—	—	—
C (calf), -	102.4	101.6	101.8	101.4	101.7	101.8	101.8	—	—	—
<i>Dec. 17-18.</i>	Max- imum	*Aver- age.								
1337, -	102.8	101.6	101.3	101.7	102.9	102.9	102.6	102.5	103.0	103.5
1341, -	102.2	101.3	101.2	102.0	102.3	103.0	102.2	102.6	102.1	101.5
1343, -	102.2	101.5	101.1	102.0	101.9	102.4	102.0	101.8	101.0	101.8
1344, -	102.3	101.0	101.5	102.2	104.4	106.4	107.0	105.7	104.4	102.8
A (calf), -	101.8	101.1	100.8	101.8	101.6	101.6	100.9	102.2	101.8	101.0
B (calf), -	101.8	101.3	101.0	101.2	101.0	101.2	101.9	101.7	102.2	100.8
C (calf), -	102.2	101.4	101.0	101.5	101.2	101.4	101.7	101.7	102.2	101.4
D (calf), -	102.6	102.1	102.0	101.7	101.2	102.0	101.8	102.0	102.0	102.0

TABLE 2.—(Continued.)

DATE OF TEST AND NUMBER OF ANIMAL.	BEFORE INJECTION.		AFTER INJECTION.							
			6 A. M.	8 A. M.	10 A. M.	12 M.	2 P. M.	4 P. M.	6 P. M.	8 P. M.
<i>Apr. 11-12,</i> <i>1898.</i>	Max- imum	*Aver- age.								
1337, -	101.8	101.3	101.8	102.6	102.3	102.2	101.8	101.8	101.9	102.0
1341, -	101.8	101.3	102.0	102.6	102.4	102.6	101.9	102.0	101.8	101.6
1343, -	102.1	101.5	102.3	104.0	104.2	104.5	104.0	102.5	101.9	102.0
1344, -	101.2	100.8	101.7	102.5	102.7	102.8	102.7	103.0†	103.2†	103.0†
A (calf), -	102.2	101.4	101.6	101.8	101.6	102.0	101.8	101.3	102.0	102.0
B (calf), -	101.9	100.9	100.5	101.0	100.6	100.6	100.8	100.5	101.4	101.4
D (calf), -	102.3	101.8	102.3	101.8	101.7	101.7	102.0	102.7	102.6	102.6
<i>Dec. 22-23,</i> <i>1898.</i>										
1337, -	103.0	101.9	101.2	102.2	102.9	102.0	101.9	101.3	101.3	—
1341, -	103.0	101.7	102.6	103.8	103.9	100.0	100.8	102.1	101.9	—
1343, -	103.0	102.1	104.2	103.8	103.8	101.5	102.1	102.3	101.7	—
1344, -	102.4	101.4	101.6	102.0	102.4	101.4	100.8	101.1	101.3	—
A (calf), -	102.5	101.5	101.4	101.7	102.2	102.6	103.1	102.5	102.5	—
B (calf), -	102.2	101.7	104.4	106.2	106.3	104.9	106.0	105.3	105.0	—
C (calf), -	102.2	100.6	102.1	102.3	101.4	101.6	102.9	101.6	—	—
D (calf), -	102.2	101.9	101.6	102.2	101.8	102.0	101.7	101.9	101.9	—
E (calf), -	102.8	102.0	101.5	101.7	101.4	102.1	101.7	101.8	101.6	—
F (calf), -	103.3	102.1	102.0	102.0	101.6	102.5	101.6	101.6	102.7	—
G (calf), -	103.0	102.6	101.4	101.8	100.8	102.2	103.1	102.9	102.2	—
H (calf), -	102.4	102.0	102.6	101.4	101.5	101.2	101.4	101.4	101.8	—

Three of the cows, No. 1337, 1341, and 1343, were due to calve in August or September, 1898, and for this reason it was thought best to discontinue the tuberculin tests for several months. These three cows were dried off during the latter part of June, and were placed in a small pasture separate from all other stock, where they were allowed to remain until they were about ready to calve. The next tuberculin tests of the cows were made December 22 and 23, 1898, and at that time none of the cows gave any response, either in physical symptoms or rise of temperature.

PHYSICAL CONDITION OF THE COWS FROM OCTOBER, 1896, TO FEBRUARY, 1899.

Cow No. 1337. This animal was a heifer which had produced one calf prior to coming to the Station in November, 1896. She was due to calve in April, 1897. She remained in

* Average of temperatures taken every three hours M.-12 P., 6 A. M.

† Noticed to be in heat at 8 P. M.

fair flesh during the winter of 1896-7, and was dry about three months. She dropped a strong heifer calf on April 5th. From birth till September 20th the calf sucked its dam. During this time the cow seemed a little thin in flesh, although not noticeably so considering her condition of milk. This cow gained in size and flesh during the winter of 1897-8. She was kept at pasture while dry, from the latter part of June until September 15, 1898, at which time she dropped a strong, vigorous heifer calf. The calf has sucked its dam from birth to the present writing (February, 1899). For the first two months after calving the cow seemed a little thin in flesh, but at the present time she is in good order. This cow has had no cough since she was brought to the Station, and has looked strong and vigorous, eating well and appearing in good health at all times.

Cow No. 1341. This cow was pregnant at the time she was brought to the Station in November, 1896. The exact time that she was due to calve could not be ascertained, but it was supposed that she would calve in March or April, 1897. She was dry for about two months, and dropped a dead calf March 2, 1897. The foetus was well covered with hair, and appeared to be premature by about one month. A careful physical examination of the calf, made by the College veterinarian, failed to show the presence of tuberculosis, and cultures made from several sections of the body failed to reveal the germs of tuberculosis. The cow was quite thin in flesh for about three months after calving, but gained slightly during the following summer. She was quite a heavy milker, and this fact may account in part for her thinness in flesh. During the winter of 1897-8 she gained in flesh, and in April, 1898, appeared in fair physical condition. At times during the winter she had a chronic looseness of the bowels, but no cough was observed. This cow was dry from about the middle of June until the time of calving, August 11, 1898, and during this period she was kept at pasture. For about a month after calving she seemed to be running down in flesh, but soon began to gain, and by the time the cows were placed in their winter quarters she was in fair flesh. She has produced quite a heavy flow of milk ever since dropping her last calf. At the present time (February, 1899) she seems to be a little thin in flesh, although no cough has been noticed. She continues to eat well, and appears in a fair state of health.

Cow No. 1343. This cow produced a calf in September or October, 1898. She is a lighter milker than the other cows, has a somewhat beefy form, and shows a tendency to lay on fat. During the winter of 1897-8 she became quite fat and sleek. In March, 1898, she was noticed to have a slight cough, but otherwise appeared in good physical condition. She was dried off about the middle of June, and was placed at pasture. August 28, 1898, she dropped a small heifer calf. For two or three months after calving she became somewhat thinner in flesh than usual, but soon after being placed in winter quarters she began to gain. From November, 1898, to the present time (February, 1899), she has had quite a persistent cough. Otherwise she appears in a fair state of health, although not quite as fat as during the winter of 1897-8.

Cow No. 1344. This cow calved in September or October, 1896. She gave a fair flow of milk during the winter of 1896-7, and became quite fat and beefy. During the summer of 1897 this cow became rather thin in flesh, although she had no cough, and appeared in good physical condition. Although several attempts were made to have this cow become pregnant, she remained "farrow" throughout the winter of 1897-8, and since that time. At the present writing (February, 1899) she has continued to produce milk without interruption for nearly two years and a half. During the present winter she has become fatter than usual, and from general appearances seems to be in a good state of health.

On May 8, 1898, and again February 7, 1899, the College veterinarian made careful physical examinations of the animals. The reports which he has made as to the physical condition of the cows is appended to this article.

Physical Examinations.

On May 8, 1898, Prof. N. S. Mayo, the College veterinarian, made a physical examination of the animals. The report of this examination was given in the article on the subject in the last report of the Station for 1898. It is reproduced here for comparison with the report of the examination made by the same veterinarian on February 7, 1899. These reports are as follows:

Report of Veterinarian, May 8, 1898. — It is a fact well recognized that bovine tuberculosis, unless well advanced, is one of the most difficult diseases to diagnose upon a physical examination.

Of the seven animals examined four are the Devon cows that have been tested and found to respond at one time or another, three (A, B, and D) are young bulls that have been fed with the milk of the cows. The calves have not reacted to the tuberculin test, and a careful physical examination fails to reveal any indications that they have tuberculosis.

Of the four cows that have responded to the test, No. 1337 presents no symptoms of tuberculosis. She is in good flesh and looks well. Her temperature was 102.2° F., respiration full and at the rate of twelve per minute.

Cow No. 1341 is thinner in flesh than any of the others, and seems to be affected with a slight but chronic looseness of the bowels. Her temperature was 102° F., and respirations twelve per minute.

Cow No. 1343 is rather fat. She is troubled with a chronic cough, and auscultation indicates that the anterior (cephalic) lobes of the lungs, especially the right, are tuberculous. Her temperature was 102.6 F., and respirations are twenty-two per minute. Cows Nos. 1337, 1341, and 1343 are pregnant.

Cow No. 1344 is in good flesh. Temperature 101.8° F., and respirations fifteen per minute. Nothing abnormal could be detected upon a physical examination. No enlarged glands could be detected in any of the animals examined. Of the four cows that have at some time responded to the test, Nos. 1337 and 1344 show no symptoms of the disease having developed. In No. 1341 the chronic looseness of the bowels may be considered as a suspicious symptom of a tubercular affection of the digestive tract. In No. 1343 the physical symptoms indicate tuberculosis of the lungs.

It must be remembered that all of these animals have had good care and attention, and have not been exposed to conditions or circumstances that would cause the disease to develop.

Report of the Veterinarian, Feb. 7, 1899. — Of the four Devon cows examined, No. 1337 does not seem to be in as thrifty condition as she ought to be, considering her care and feed. No. 1341 is not in as thrifty condition as No. 1337, and would probably be condemned as tuberculous on a physical examination. Nos. 1343 and 1344 are in excellent condition, physically, both being rather fat, and are looking well. The only evidence of disease is found in No. 1343, her respirations not being as full and deep as they should be normally. No cough was noted in any of the animals.

N. S. MAYO, D.V.S.,
College Veterinarian.

FEEDING CALVES WITH THE MILK OF TUBERCULOUS COWS.

Soon after the cows were brought to the Station, plans were made for feeding their milk to calves from healthy cows, and in some cases to their own offspring. These experiments have been continued for a little over two years. In some cases the calves have been allowed to suck their dams, while in others

they have been fed the milk from a pail. In the experiments for the first year and a half the calves were kept in the same stable with the cows, and, of course, there was some liability that the animals might contract the disease through the breath, or food other than the milk. During this period, however, no sign of the disease was developed in any of the calves. In some later experiments, two of the calves are being kept in a room entirely separate from the cows.

Feeding calf A with the milk of cows 1344 and 1341.— This calf was dropped December 25, 1896, by a vigorous grade cow. The dam of the calf was tested with tuberculin on March 3-4, 1897, but gave no response. This calf was fed the milk of cow No. 1344 from January 7 to March 28, 1897. The calf was tested with tuberculin January 26-27, and again March 29-30, 1897, but gave no response to either of the tests. At that time, the supply of milk from cow No. 1344 being less than the calf seemed to need, it was fed the milk of cow No. 1341. This cow being quite a heavy milker, the calf was limited to about 15 or 16 pounds of milk per day for the first month. After this, calf A was given all the milk produced by cow No. 1341, which amounted to 20-24 pounds daily, for the next two months. Calf A was fed the milk of this cow from about April 1, 1897, to July 9, 1898. The calf was castrated in May, when about a year and a half old, and was sent to pasture July 9, where it remained until about the 1st of November, 1898. Beside the two tuberculin tests made while calf A was being fed the milk of cow No. 1344, several tests were made during the year and three months that it was fed the milk supply of cow 1341. The first of these tests was made July 30-31, the second September 27-28, the third December 17-18, 1897, and the last before the animal went to pasture was made on April 11-12, 1898. At no time since we began feeding this calf early in January, 1897, has it shown any effects from the tuberculin tests, or any physical symptoms that would indicate the presence of the disease. When sent to pasture in July it was a large, vigorous animal, weighing about 500 pounds. Early in November this steer was returned to the same stable with the tuberculous cows. It was again tested with tuberculin December 22-23, 1898, but gave no response. During the present winter it is being fattened for beef, and at the present time (February, 1899) the steer is in vigorous condition, and is laying on flesh quite rapidly.

Feeding calf B with milk of cow No. 1343. — This calf was dropped by a vigorous Jersey cow on February 20, 1897, and was ten days old when the feeding period began. The dam of the calf was tested with tuberculin about a year previous to the birth of this calf, and was pronounced healthy. Calf B, when about two weeks old (March 3-4) was tested with tuberculin and gave no response. From March 1, 1897, to early in July, 1898, calf B was fed the entire milk supply of cow No. 1343. This calf has not been a vigorous eater, and at times has refused single feeds of milk. The calf has seemed healthy and has eaten hay readily. When a year old, the animal was thought to be rather small for its age, but this may have been due to the fact that he had always refused grain feeds. Besides the test with tuberculin at the beginning of the feeding period, calf B was also tested July 30-31, September 27-28, and December 17-18, 1897, and April 11-12, 1898. This animal was also castrated in May, 1898, and was sent to pasture with calf A July 9, where it remained until November, 1898. It was returned to the same stable with the cows early in November, and was started upon a heavy grain ration, with a view to fattening for beef. When tested December 22-23, this steer gave a marked response to the tuberculin test. (See temperatures, Table 2, page 104.) In addition to a marked rise of temperature, the steer showed physical symptoms of roughness of the coat, shivering, and twitching of the muscles. Steer B was killed and carefully examined by the College veterinarian December 30, 1898. The only trace of the disease found was a few tubercles in one of the pharyngeal glands of the throat. The disease was without doubt of recent origin. Had the disease been produced by the milk upon which the animal was fed for sixteen months before going to pasture, the disease would, doubtless, have appeared first in the digestive tract. While, of course, there is no positive proof as to how this animal contracted the disease, it seems most probable that the germs entered the system in the breath after the animal was returned to the stable early in November, 1898.

Feeding calf C with milk of cow No. 1337. — This was a heifer calf dropped by cow No. 1337 April 5, 1897. The calf was allowed to suck its dam until about six months old. About October 1st the calf was weaned, but was fed the milk of the dam till January, 1898. It was then gradually changed

on to a skim-milk diet, and was placed in the College herd, with the intention of raising the calf for dairy purposes. Calf C was tested with tuberculin July 30-31, September 27-28, and December 17-18, 1897. During the summer of 1898 the calf was kept at pasture with other young stock, and made a vigorous growth. It was tested with tuberculin December 22-23, 1898, but gave no response. It is now nearly two years old, and is a large, vigorous animal.

Feeding calf D with milk of cow No. 1344. — This calf was dropped by a vigorous grade cow November 29, 1897. The dam was tested with tuberculin March 3-4, 1897, but gave no response to the test. The calf was first subjected to the tuberculin test December 17-18, but gave no response. Calf D was again tested April 11-12, 1898, but did not respond. This calf had all the milk produced by cow No. 1344 (about 10-12 pounds daily) from early in December, 1897, up to the present time (February, 1899). The last tuberculin test was made December 22-23, 1898, with no response. The animal has made a rapid growth and is a large, vigorous yearling at the present time.

From the records just given of the feeding of these four animals, it will be seen that each consumed the milk of a separate cow for periods varying from three months to a year and four months, and that in no case was there any sign of the disease having been contracted during these feeding periods. One animal (B) did respond to the tuberculin test nearly six months after the feeding period with milk was ended, but from the mild form in which the disease existed, and its location, it seems very doubtful if the disease was contracted through the milk. These tests point to the conclusion that the milk is not as dangerous a source of infection as has been commonly supposed.

As has already been stated, three of the cows, Nos. 1337, 1341, and 1343, produced calves in August and September, 1898. All of the calves have been fed the milk of their dams since being dropped, down to the present time (February, 1899).

Feeding calves E and F. — Calf E was a large heifer calf, dropped by cow No. 1341, August 11, 1898, and calf F was a bull calf, dropped by a grade cow in the College herd. This cow was supposed to be healthy, but within three months after

the birth of the calf developed a severe case of tuberculosis.* The calf dropped by this cow has appeared healthy and vigorous from the first. The plan of the test with these two calves was to pasteurize one-half the milk of cow No. 1341 and feed it to its own offspring, calf E, and to feed the balance of the milk, in its normal condition, to a calf from a healthy cow. Calf F was chosen for this purpose, because it was supposed that its dam was free from tuberculosis, not having responded to the test made December 30-31, 1897.

The feeding test has been continued the same as though this calf was from a perfectly healthy cow. Both of these calves have been kept in a room entirely separate from the tuberculous cows, and the two calves have been separated from each other by a double slat partition in such a way as to prevent their licking one another. The portion of the milk of cow No. 1341 which was fed to calf E has been heated to a temperature of from 170-175° F., and diluted with cold water before feeding. The balance of the milk of the same cow, in its normal condition, has been fed to calf F as soon as possible after milking. Both calves have had a small quantity of bran added to the milk since they were about two months old. These calves were tested with tuberculin December 22-23, 1898, after having been fed the milk of cow No. 1341 for about four months, but gave no response to the test. Both have grown rapidly, and are in a strong, vigorous condition at the present writing (February, 1899).

Feeding calf G.— This was a small heifer calf dropped by cow No. 1343, August 28, 1898. The calf was small at birth, and has appeared rather puny ever since. It has been fed the milk of its dam since birth, although it has not eaten well, and has only consumed small quantities of milk. The calf has seemed to lack vigor, and has remained thin in flesh and has grown slowly. It did not respond to the tuberculin

* This cow was tested with tuberculin December 30-31, 1897, but gave no response to the test. She calved August 27, 1898, and appeared in a healthy, vigorous condition until the herd was placed in winter quarters early in November. Soon after, she began to refuse silage, and dropped off rapidly in milk flow, but manifested no serious symptoms until about ten days after she began to refuse silage. At that time the cow began to scour badly, and was placed in a box stall away from the rest of the herd. For the next ten days she ran down in flesh rapidly so that it was thought wise to destroy her. A *post mortem* examination showed a severe case of tuberculosis, the tubercles being present in the liver, the spleen, and the lungs. Some of the lesions were encysted in such a way as to indicate that the disease was one of long standing, and it is probable that the tuberculin test which was made eleven months previous to the time of killing the cow failed to cause a response, owing to the advanced condition of the disease, or the failure may have been due to a poor lot of tuberculin. The cow showed no outward appearance of the disease, and remained in good condition of flesh until she began to refuse her feed early in November, 1898.

test which was made December 22-23, after it had been feeding upon the milk of its dam for nearly four months.

Feeding calf H. — This was a strong, vigorous heifer calf, dropped by cow No. 1337, September 14, 1898. The calf has suckled its dam for the past four months, and has grown rapidly. It was tested with tuberculin December 22-23, 1898, but gave no response. At the present time (February, 1899), this calf is a large, vigorous animal, and is growing rapidly.

DEDUCTIONS.

We know comparatively little regarding the conditions which favor the spread and development of tuberculosis among animals or man. Most of all are we lacking in a definite knowledge of the dangers of this disease to mankind from the bovine race. Many have claimed that the danger to mankind from the spread of the disease through the milk supply is very great. It has generally been thought that one great cause for the spread of the disease among our herds is the feeding of the milk of tuberculous cows to calves. The experiments made during the past two years at this Station do not substantiate this view. It must be borne in mind, however, that the number of experiments is comparatively few, and that the cows whose milk was used were probably in the earlier stages of the disease. These facts have been carefully considered, and it is of course unwise to attempt to draw any definite conclusions from the work, but the following deductions seem warranted:

(1) *Bovine tuberculosis is usually a disease of slow development, its progress depending quite largely upon the general vigor of the animal and its power to resist the action of the germs. In nearly two years and a half that the tuberculous cows have been at the Station, only one secondary case has appeared, and this was discovered about six months after the feeding period with milk had ended.*

(2) *In the experiments here reported, eight calves have been fed upon the milk of tuberculous cows for periods varying from three months to sixteen months without developing the disease.*

(3) *The results of these experiments coincide with the general results of European observations, and indicate that the danger from the spread of tuberculosis through the milk of cows to man or to other animals is not as great as has generally been supposed. In the earlier stages of the disease and at all times when the udder is not affected, the danger from the use of the milk is quite limited. Great stress, however, should be laid on the danger of using milk from cows which show any symptoms of udder affection.*

EFFECT OF NITROGENOUS FERTILIZERS UPON THE YIELD AND THE COMPOSITION OF CERTAIN GRASSES, GRAINS, AND LEGUMES.

BY W. O. ATWATER AND C. S. PHELPS.

Soon after its organization, in 1888, the Station took up the study of the effects of nitrogenous fertilizers upon the yields and composition of corn, oats, and mixed grasses. Field experiments on the different crops were undertaken, in continuation of a series which, for a number of years previous, had been conducted on farms in different places at the suggestion of one of us (W. O. A.). These experiments were carried on during a considerable period of years for the twofold purpose: first, of studying, by the effect upon the yields of different crops, the relative economy of different kinds and quantities of nitrogenous fertilizers when used with uniform quantities of mineral fertilizers (phosphoric acid and potash); and second, of studying the effect of the nitrogen of the fertilizer upon the percentage of nitrogen compounds (protein) in the plants.

After a few years the Station began a series of experiments with several species of grasses. These were similar to the experiments with corn, oats, and mixed grasses, except that they were conducted upon very small plots. In these experiments, because the plots were so small, no attempt was made to study the effects of the fertilizers upon the yields. The crops were carefully sampled, however, and the effect of the nitrogen in the fertilizers upon the percentages of nitrogen compounds (protein) in the plants was determined. In some cases these experiments have been continued with the same species of grasses and the same fertilizers on the same plots for several years in succession. Within the past few years the Station has undertaken also a series of experiments upon a few of the legumes, for the purpose of comparing the effects of nitrogenous fertilizers upon the plants of this family with the effects of the same kinds and amounts of fertilizers upon plants of the grass family.

Of all the constituents of fertilizers nitrogen is the most costly. In the standard commercial fertilizers at the present time (1899) nitrogen costs from 11 to 15 cents per pound, while

phosphoric acid and potash cost from 3 to 7 cents per pound.* Furthermore, nitrogen is the most unstable of all the fertilizing ingredients; for if it is available in larger quantities than are immediately used by the crop it is readily wasted in various ways. It is very important, therefore, that the farmer should know the kinds of fertilizing materials and the amounts per acre in which he can use nitrogen for the different crops to the best advantage. In the experiments reported herewith, nitrogen has been supplied in nitrate of soda, in sulphate of ammonia, and in dried blood. Of these materials, nitrate of soda is the one in which the nitrogen is considered most available to the plants; sulphate of ammonia yields its nitrogen a little more slowly, while the nitrogen of organic materials, like dried blood, is commonly the least available. The amounts of each of these materials used in the experiments varied according to the amount of nitrogen required by the experiment, as explained later on pages 117 to 119, under the descriptions of "soil test" and "special nitrogen" experiments.

While nitrogen is the most expensive ingredient in fertilizers, it is at the same time the basis of the costly but very valuable and important ingredient of feeding stuffs, protein. Protein compounds generally contain about 16 per cent. of nitrogen. On most farms in New England the amount of protein produced is much less than is needed for feeding purposes. To supply this deficiency the farmer often has to buy large quantities of such feeds as bran, middlings, cotton-seed and gluten meals, etc. The problem for him, therefore, is to find out how he can increase the amount of protein produced on his farm, and do it more cheaply than he can buy it in feeding stuffs.

There are two ways in which the farmer may increase the amount of protein produced upon his farm. One way is to grow more of the leguminous crops, such as clover, soy beans, and the like, which not only contain large proportions of protein, but gather much of their nitrogen from the air and do not require it in fertilizers. The other way is to increase the relative proportions of protein in the grasses and cereals by the proper use of nitrogenous fertilizers. Both methods are practical, as shown by the experiments summarized in this article. The fact that the yield of the common grasses and the cereals is largely increased by the use of nitrogenous fertilizers, while

* See page 121.

the yield of the legumes is but little affected by their use, has long been known. The power of the legumes to utilize the free nitrogen of the air, though a comparatively recent discovery, is already well known by farmers as well as scientific investigators. The increase in the protein content of cereals and grasses generally, caused by nitrogenous fertilizers, is not widely understood. Indeed, we are not familiar with any previous investigations in which it has been shown upon any considerable scale; and certainly it is not current in writings upon the use and effect of nitrogen in fertilizers.

NUMBER, GENERAL PLAN, AND GENERAL CLASSIFICATION
OF THE EXPERIMENTS.

The following table gives a general classification of the experiments showing the kinds of crops thus far experimented with by the Station, the kind of experiment, whether "soil test" or "special nitrogen," the years in which the experiments were conducted, the number of experiments made with each crop, the size and the number of the plots, and the number of analyses made of samples of the products. Details of these experiments may be found in the Reports of the Station for either the year in which the experiment was made or the year following.

TABLE 3.—*Classification*

Crops.	Kind of experiment.	Years in which experiments were made.
<i>Grasses.</i>		
Mixed grasses,	Special nitrogen	1890, 91, 92
Timothy,	" "	1891, 92, 93, 94, 96, 97, 98
Orchard grass,	" "	1891, 92, 93, 94, 96, 97, 98
Tall meadow fescue,	" "	1893, 94, 96, 97, 98
" " " " " " " " " " " "	" "	1891
Tall red top,	" "	1896, 97
" " " " " " " " " " " "	" "	1891, 92
Brome grass,	" "	1896, 98
Tall meadow oat grass,	" "	1893, 94
" " " " " " " " " " " "	" "	1892
Fowl meadow grass,	" "	1891
Kentucky blue grass,	" "	1892
English rye grass,	" "	1891
<i>Cereals.</i>		
Corn (Maize), seed,	Soil test	1888, 89, 90
" " stover,	" "	1888, 89, 90
" " seed,	Special nitrogen	1888, 89, 95, 96
" " stover,	" "	1888, 89, 95, 96
Oats, seed,	Soil test	1892
" straw, . . . . .	" " " " " " " " " " " "	.....
" seed,	Special nitrogen	1890, 92
" straw,	" "	1890, 92
<i>Legumes.</i>		
Cow pea fodder,	" "	1895, 96, 97, 98
Soy bean seed,	" "	1895, 96, 97, 98
Total,		

The number of experiments in each category in the table represents the number of separate field experiments in which samples were taken for analysis. Each field experiment included several plot experiments. The same experiments were repeated, in several instances, through quite a number of years. It will be noticed that the number of plot tests and the number of analyses do not agree in all cases. This is due to the fact that in some of the experiments duplicate samples were taken and were analyzed separately; while in a few other experiments samples from plots having nitrogen in the same quantities, but in different materials, were combined and analyzed as one sample. In most of the experiments with cereals the seeds and the straw or stover were analyzed separately. In a few of them, however, only the seeds were analyzed. In the experiments with one of the leguminous crops (the soy beans) it was found impracticable to get the samples of the leaves and the

of the experiments.

Size of plots.	No. of experiments.	No. of plots.	No. of analyses.
20 sq. rods	3	25	46
2 sq. rods	7	28	28
2 sq. rods	7	28	28
2 sq. rods	5	20	20
64 sq. feet	1	2	2
2 sq. rods	2	8	8
64 sq. feet	2	4	4
2 sq. rods	2	8	8
2 sq. rods	2	8	8
64 sq. feet	1	2	2
64 sq. feet	1	2	2
64 sq. feet	1	2	2
64 sq. feet	1	2	2
8, 13½, 16, or 20 sq. rods	4	39	35
8, 13½, 16, or 20 sq. rods	4	39	35
3 2, 8, or 16 sq. rods	8	129	117
3.2, 8, or 16 sq. rods	8	129	117
13½ sq. rods	1	12	12
8 or 16 sq. rods	2	26	26
8 or 16 sq. rods	2	26	26
6.4 sq. rods	4	40	51
6.4 sq. rods	4	40	33
	72	619	612

straw, because the plants dropped their leaves to large extent before the seeds were fully matured.

Soil Test Experiments.—The experiments which have been called "soil tests" were undertaken primarily to learn the deficiencies of the soils in regard to the essential ingredients of plant food, especially the phosphoric acid, potash, or nitrogen needed to produce the given crop. The plan of the experiments for soil tests consists in applying, upon parallel plots of land, fertilizers containing nitrogen, phosphoric acid, and potash. The quantities were generally such as to supply about 25 pounds of nitrogen, 53 pounds of phosphoric acid (P_2O_5), and 82 pounds of potash (K_2O) per acre. These ingredients were applied to different plots singly, in all combinations of two, and finally all three together. The arrangement of the

plots of the experiment, the kinds and quantities of the materials used, and of the principle fertilizing ingredients contained in them are shown in the following outline plan.

*Plan of soil test experiment.**

Plot No.	MATERIALS.		FERTILIZING INGREDIENTS PER ACRE.		
	Kinds.	Amounts per acre.	Phosphoric acid.	Potash.	Nitrogen.
		lbs.	lbs.	lbs.	lbs.
O	Nothing, . . . . .	.....	.....	.....	.....
A	Nitrate of soda,	160	.....	.....	25
B	Dissolved boneblack,	320	53	.....	.....
C	Muriate of potash,	160	.....	82	.....
D	{ Dissolved boneblack,	320	53	.....	.....
	{ Nitrate of soda,	160	.....	.....	25
E	{ Muriate of potash,	160	.....	82	.....
	{ Nitrate of soda,	160	.....	.....	25
F	{ Dissolved boneblack { mixed	320	53	.....	.....
	{ Muriate of potash, { minerals }	160	.....	82	.....
	{ Dissolved boneblack,	320	53	.....	.....
G	{ Muriate of potash,	160	.....	82	.....
	{ Nitrate of soda,	160	.....	.....	25

* Unmanured strips separate the plots.

"Special Nitrogen" Experiments.—The object of these experiments, which were made with corn, oats, and mixed grasses, has been to study the effects of nitrogen in different amounts and combinations upon the different crops. The nitrogen was supplied as nitric acid in nitrate of soda, as ammonia in sulphate of ammonia, and as organic nitrogen in dried blood. Phosphoric acid was supplied as superphosphate in dissolved boneblack, and potassium was supplied in muriate of potash.

The amounts of nitrogen used were 25, 50, and 75 pounds per acre. The quantity of phosphoric acid used was 53 pounds, and of potash 82 pounds per acre. These quantities of phosphoric acid and potash are, on the average, such as analyses indicate may be contained in a corn crop of 60 bushels of shelled corn per acre, with the corresponding stover. It is assumed that the same crop would contain 75 pounds of nitrogen, which amount per acre is accordingly designated as a full ration; and 50 pounds is therefore called a two-third, and 25 pounds a one-third ration. The general plan of "Special Nitrogen" experiments is shown in outline as follows:

*Plan of special nitrogen experiments.**

Plot No.	MATERIALS FOR FERTILIZERS.		FERTILIZER INGREDIENTS PER ACRE.		
	Kind.	Amounts per acre	Phosphoric acid.	Potash.	Nitrogen.
	<i>Preliminary group</i>	lbs.	lbs.	lbs.	lbs.
0	Nothing, . . . . .	.....	.....	.....	.....
1	Nitrate of soda,	160	.....	.....	25
2	Dissolved boneblack,	320	53	.....	.....
3	Muriate of potash,	160	.....	82	.....
4	{ Dissolved boneblack,	320	53	.....	.....
	{ Nitrate of soda,	160	.....	.....	25
5	{ Muriate of potash,	160	.....	82	.....
	{ Nitrate of soda,	160	.....	.....	25
6	{ Dissolved boneblack, { mixed	320	53	.....	.....
	{ Muriate of potash, { minerals }	160	.....	82	.....
00	Nothing, . . . . .	.....	.....	.....	.....
	<i>Nitrate of soda group</i>				
6a	{ Dissolved boneblack, { mixed	320	53	.....	.....
	{ Muriate of potash, { minerals }	160	.....	82	.....
	{ Dissolved boneblack,	320	53	.....	.....
7	{ Muriate of potash,	160	.....	82	.....
	{ Nitrate of soda,	160	.....	.....	25
	{ Dissolved boneblack,	320	53	.....	.....
8	{ Muriate of potash,	160	.....	82	.....
	{ Nitrate of soda,	320	.....	.....	50
	{ Dissolved boneblack,	320	53	.....	.....
9	{ Muriate of potash,	160	.....	82	.....
	{ Nitrate of soda,	480	.....	.....	75
00	Nothing, . . . . .	.....	.....	.....	.....
	<i>Sulphate of ammonia group</i>				
6b	{ Dissolved boneblack, { mixed	320	53	.....	.....
	{ Muriate of potash, { minerals }	160	.....	82	.....
	{ Dissolved boneblack,	320	53	.....	.....
10	{ Muriate of potash,	160	.....	82	.....
	{ Sulphate of ammonia,	120	.....	.....	25
	{ Dissolved boneblack,	320	53	.....	.....
11	{ Muriate of potash,	160	.....	82	.....
	{ Sulphate of ammonia,	240	.....	.....	50
	{ Dissolved boneblack,	320	53	.....	.....
12	{ Muriate of potash,	160	.....	82	.....
	{ Sulphate of ammonia,	360	.....	.....	75
00	Nothing, . . . . .	.....	.....	.....	.....
	<i>Dried blood group</i>				
6c	{ Dissolved boneblack, { mixed	320	53	.....	.....
	{ Muriate of potash, { minerals }	160	.....	82	.....
	{ Dissolved boneblack,	320	53	.....	.....
13	{ Muriate of potash,	160	.....	82	.....
	{ Dried blood,	200	.....	.....	25
	{ Dissolved boneblack,	320	53	.....	.....
14	{ Muriate of potash,	160	.....	82	.....
	{ Dried blood,	400	.....	.....	50
	{ Dissolved boneblack,	320	53	.....	.....
15	{ Muriate of potash,	160	.....	82	.....
	{ Dried blood,	600	.....	.....	75
0	Nothing, . . . . .	.....	.....	.....	.....

* Unmanured strips between the plots.

It will be noticed that the plots are arranged in groups. Upon those of the preliminary group the fertilizing ingredients are applied singly in plots 1—3, and two by two in plots 4—6. The combination on plots 6, 6a, 6b, 6c, is designated as "mixed minerals," and is used as a basis to which the nitrogenous materials are added for the mixtures used upon all the plots of the succeeding groups. As the dried blood has but little, and nitrate of soda and sulphate of ammonia have no phosphoric acid or potassium, the quantities of these mineral fertilizers used are kept constant. By comparing the yields from the plots having "mixed minerals" alone, with the yields from the plots having nitrogenous fertilizers in addition to the mixed minerals, the effects of the nitrogen upon the yield may be learned.

It will be observed, furthermore, that the preliminary group Nos. 1 — 5, with "mixed minerals" No. 6, and No. 7 of the nitrate of soda group are practically the same as Nos. A—G of the "soil tests" described above.

In some of the experiments as actually made, the three numbers of the dried blood group (13, 14, 15) were replaced by mixtures in which nitrate of soda, sulphate of ammonia, and dried blood were used instead of dried blood alone. In several instances the preliminary group or one of the nitrogenous groups was omitted. So-called "nothing" plots, *i. e.*, plots without any fertilizer, were provided before, between, and after the several groups.

Special Nitrogen Experiments on Small Plots.—In the regular special nitrogen experiments as in the soil tests, the individual plots were generally one-tenth to one-twentieth of an acre each. A number of special nitrogen experiments with different species of grasses, however, were made in the grass garden of the Station. In most of these experiments the plots were quite small, being two square rods (one-eightieth of an acre) each, while a few were even smaller. The number of groups and of plots in a group was also reduced, so that there were generally only four plots in each group, comprising a nothing plot, a plot with mixed minerals, a plot with minerals and the one-third ration (25 lbs.) of nitrogen, and a plot with minerals and the full ration (75 lbs.) of nitrogen.

COST OF FERTILIZERS.

In the calculations of the financial gains from the use of the fertilizers the present prices of fertilizing materials have

been used. The cost of mixing the materials, of transportation, etc., is left out of account. The 1899 list of commercial valuations adopted by the New England Experiment Stations* in estimating the value of fertilizers is used. This represents the cash cost of the various ingredients of fertilizers, as found in chemicals offered for sale in the larger markets. In many cases, especially where considerable amounts of fertilizers are used, farmers can buy the fertilizing materials at the prices indicated in the list. The prices upon which are based calculations of gains in this discussion are as follows:

Nitrogen in nitrate of soda,	12½ cents per pound.
Nitrogen in sulphate of ammonia,	15 cents per pound.
Nitrogen in organic materials (dried blood),	14 cents per pound.
Potash in muriate,	4½ cents per pound.
Phosphoric acid (soluble)	4½ cents per pound.

All the phosphoric acid used was estimated as soluble, although a small part of it was probably in the form known as reverted phosphoric acid. The proportion in this form could not be estimated; but as the valuation for reverted phosphoric acid is only one-half cent per pound less than that for soluble, the difference in the final results would be small.

EFFECTS OF NITROGENOUS FERTILIZERS UPON THE YIELDS, AND THE ESTIMATED FINANCIAL GAINS.

The detailed accounts of the experiments found in earlier Reports of the Station give results with regard to the yields and the estimated financial gains. It has seemed advisable to summarize briefly these results, indicating the relation between the yields of the crops and the quantity of nitrogen used in the fertilizer, as well as the relative financial gain resulting from the use of different quantities of nitrogen.

In estimating the financial gains the current market prices are taken as bases of valuation of the crops, as these represent what the farmers would receive or pay for them. The feeding value, however, is influenced considerably by the percentage of protein in the crops, which is left entirely out of account in buying or selling. For this reason, the proportion of nitrogen in the fertilizer that would be most advantageous to the producer if he intended to sell his crop might be considerably less

* Not yet published

than he could afford to apply if he intended to feed the crop to his own stock instead of selling it. A discussion of the effects of nitrogenous fertilizers upon the proportion of nitrogen compounds (protein) in the crop will be found in the next division of the subject.

Effects upon Yields of Hay of Mixed Grasses.— During the years 1890, 1891, and 1892, three experiments were carried on with mixed grasses. Ten plots one-eighth of an acre each were used in each of these experiments. Nitrogen was applied upon some of these plots in nitrate of soda and upon others in sulphate of ammonia. Similar effects upon yields of dry matter and protein followed the use of either of these materials in these experiments. The effects of the different quantities of nitrogen when used with uniform quantities of mineral fertilizers are shown in the following table. The weights of the yields per acre represent the averages of the yields from plots upon which the same kinds and amounts of fertilizers were used.

TABLE 4.

Comparison of yields of hay from plots upon which were used fertilizers supplying different quantities of nitrogen.

Plot No.	Kinds and amounts of fertilizers per acre.	YIELD PER ACRE (11.1 % WATER).*	
		Comparative scale, 2,600 lbs. to the inch.	lbs.
0, 00	Nothing,		1881
6a, 6b	{ Dissolved boneblack,		2664
	{ Muriate of potash,		
7, 10	{ Mixed min. as plot 6a,		3645
	{ Nitrogen,		
8, 11	{ Mixed min. as plot 6a,		4727
	{ Nitrogen,		
9, 12	{ Mixed min. as plot 6a,		5015
	{ Nitrogen,		

* While the water content of different crops of hay varies with the curing, it has been thought best to calculate the yields upon the basis of $\frac{1}{10}$ (11.1 %) water, which appears to be about the average.

From this table it will be observed that the yields increased quite rapidly, in a general way, with the increase in the quantity of nitrogen applied. However, the difference between the yield from the use of 75 pounds of nitrogen per acre, and the yield from the use of 50 pounds per acre, was not so great as the difference between the yield from the use of 50 pounds per acre and that from the use of 25 pounds per acre.

The mineral fertilizers, when used alone on mixed grasses, were applied at a financial loss, as no material increase in the total yield followed their use. They did, however, increase somewhat the yield of clover in the crop, which accords with the results of experiments with legumes discussed on a later page..

From Table 5, which follows, it will be seen that, with the valuation of hay at \$12 per ton, in an average of all the similar experiments the profits from the use of 160 pounds of nitrate of soda (25 pounds of nitrogen), was \$3.05 per acre; from the use of 320 pounds of nitrate of soda (50 pounds nitrogen), \$6.61 per acre; and from the use of 480 pounds of nitrate of soda (75 pounds of nitrogen), \$4.47 per acre. The profits from the use of the same amounts of nitrogen in sulphate of ammonia were somewhat less, because the cost of the fertilizer is greater, although the yields of hay were quite similar.

TABLE 5.—*Yields of hay with fertilizers supplying mineral in-
yields with mineral fertilizers alone,*

Plot No.	Kinds and amounts of fertilizers per acre.	lbs.
0	Nothing.	.....
7	{ Mixed minerals, as plot 6a,	480
	{ Nitrate of soda (25 lbs. nitrogen),	160
8	{ Mixed minerals, as plot 6a,	480
	{ Nitrate of soda (50 lbs. nitrogen),	320
9	{ Mixed minerals, as plot 6a,	480
	{ Nitrate of soda (75 lbs. nitrogen),	480
6a	{ Dissolved boneblack, } mixed minerals, {	320
	{ Muriate of potash, }	160
10	{ Mixed minerals, as plot 6a,	480
	{ Sulphate of ammonia (25 lbs. nitrogen),	120
11	{ Mixed minerals, as plot 6a,	480
	{ Sulphate of ammonia (50 lbs. nitrogen),	240
12	{ Mixed minerals, as plot 6a,	480
	{ Sulphate of ammonia (75 lbs. nitrogen),	360
00	Nothing.	.....
66	Mixed minerals, as plot 6a,	480

* Total value, less cost of fertilizer.

Effects upon Yields of Corn.—Between the years 1878 and 1881, a large number of field experiments with corn were conducted, under the supervision of one of us (W. O. A.), upon farms, mostly in New England. The results of these experiments, together with those of a large number of other field experiments with fertilizers, were summarized in a publication by the United States Department of Agriculture, entitled "Results of Field Experiments with various Fertilizers." During the years 1888 and 1889, the Station also carried on some field experiments with this crop. The object of these experiments was to study the effects of different quantities of nitrogen in the fertilizers upon the yields of the crop. The results with regard to the effect upon the yields of shelled corn are briefly summarized on the following page by the averages of the yields from all the experiments in which the conditions were similar.

Four soil tests and eight special nitrogen experiments, comprising 168 plots, were carried out with corn between 1888 and 1896. The results of the nitrogen experiments, with a valuation of the increase in yield following the use of different

gradients and different quantities of nitrogen, as compared with the and the corresponding profits.

Cost of fertilizer.	Yield of hay, 11 per cent. water.	Increase over yield from mineral plots.	VALUE OF INCREASE AT \$12.00 PER TON.		Yield of protein per acre.	Plot No.
			Total.	Net.*		
\$	lbs.	lbs.	\$	\$	lbs.	
.....	1,639	.....	.....	.....	117	0
9.21	3,724	1,030	6.18	3.05	289	7
12.33	4,837	2,143	12.86	6.61	420	8
15.46	5,003	2,309	13.85	4.47	480	9
6.08	2,511	.....	.....	.....	214	6a
9.83	3,804	1,110	6.66	2.91	285	10
13.58	4,807	2,113	12.68	5.18	410	11
17.33	5,136	2,442	14.65	3.40	487	12
.....	2,244	.....	.....	.....	165	00
6.08	2,876	.....	.....	.....	227	6b





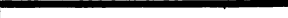




Summary of field experiments with corn made between 1878 and 1889.

Special nitrogen experiments.	Eighteen experiments, 1878-81.	Four experiments, 1888.	Three experiments, 1889.
	Bush. per acre.	Bush. per acre.	Bush. per acre.
Mixed minerals,	43.0	33.4	18.2
Mixed minerals + 25 lbs. nitrogen,	48.4	38.2	25.2
Mixed minerals + 50 lbs. nitrogen,	48.8	40.2	32.7
Mixed minerals + 75 lbs. nitrogen,	49.6	39.2	34.0

quantities of nitrogen, are given in Table 6 on the following page. The figures for yield per acre represent, in each case, the average of the yields of dry matter from all the plots upon which the same kinds and amounts of fertilizers were used. The amounts of dry matter in the yield are calculated from the weight of the crop when it was harvested, upon the assumption

that well dried shelled corn contains 11.1 per cent. (one-ninth) water, and well cured stover 14.3 per cent. (one-seventh) water, these proportions being considered fair averages.

TABLE 6.— *Comparison of yields of corn (grain) from plots upon which different quantities of nitrogen were used.*

Plot No.	Kinds and amounts of fertilizers per acre.		YIELD PER ACRE (11.1 % WATER).	
			Comparative scale, 1,600 lbs. to the inch.	lbs.
		lbs.		
0, 00, 000	{ Nothing, . . . . .	....		1197
6, 6a,	{ Dissolved boneblack,	320		1778
6b, 6c	{ Muriate of potash,	160		
7,	{ Mixed min. as plot 6,	480		2399
10, 13	{ Nitrogen,	25		
8,	{ Mixed min. as plot 6,	480		2937
11, 14	{ Nitrogen,	50		
9,	{ Mixed min. as plot 6,	480		3004
12, 15	{ Nitrogen,	75		

From this table it appears that the yields of corn increased with the amount of nitrogen in the fertilizer until the nitrogen in the latter reached 50 pounds per acre. When the nitrogen

TABLE 7.— *Yields of corn (grain) and stover by the use of fertilizers the use of mineral fertilizers alone,*

Plot No.	Kinds and amounts of fertilizers per acre.		Cost of fertilizer.	
		lbs.		\$
0, 00,* 000	{ Nothing, . . . . .	....	.....	.....
6, 6a,	{ Dissolved boneblack,	320	{ mixed minerals,	6.08
6b, 6c	{ Muriate of potash,	160		
7,	{ Mixed minerals. as plot 6,	480	{	9.53
10, 13	{ Nitrogen (in different materials),	25		
8,	{ Mixed minerals, as plot 6,	480	{	12.98
11, 14	{ Nitrogen (in different materials),	50		
9,	{ Mixed minerals, as plot 6,	480	{	16.43
12, 15	{ Nitrogen (in different materials),	75		

* In these tables the data from the plots having like kinds and amounts of fertilizers have been combined, and averages taken.

was increased to 75 pounds per acre, there was practically no increase in the yield. In this respect the results differ somewhat from the results of similar experiments with the grasses, discussed on preceding pages; for in these experiments there was observed considerable further increase in yield after the nitrogen in the fertilizers exceeded 50 pounds per acre. This would seem to indicate that, for increasing the weight of the yield, nitrogen is not so effective upon corn as it is upon the grasses.

But while the yield of corn from the use of 75 pounds of nitrogen per acre was little or no greater than that from the use of 50 pounds, the feeding value of the crop from the use of 75 pounds was much higher than that of the crop from the use of 50 pounds. This may be seen by a comparison of the figures in Table 7 herewith.

From this table it appears that although the difference between the yield of grain and stover from the use of 75 pounds of nitrogen per acre and the yield from the use of 50 pounds per acre is relatively quite small, the difference between the yield of protein in the crops from the use of 75 pounds of nitrogen per acre and that in the crop from the use of 50 pounds per acre is considerable.

The valuation of the increase in the yields, with corn at 60 cents per bushel, and stover at \$6 a ton, shows very clearly *supplying different quantities of nitrogen, as compared with yields by and the corresponding profits.*

YIELD OF DRY MATTER PER ACRE.		INCREASE OVER YIELD FROM MINERAL PLOTS.		VALUE OF INCREASE. (Corn, 60 cents bush., Stover, \$6.00 ton.)		Total yield of protein.	Plot No.
Grain—11.1 p. c. Water.	Stover—14.3 p. c. Water.	Grain.	Stover.	Total.	Net.*		
lbs.	lbs.	lbs.	lbs.	\$	\$	lbs.	
1,197	1,475	.....	.....	.....	.....	233	0, 00,*
1,778	2,189	.....	.....	.....	.....	289	000,
2,399	2,507	621	318	7.61	4.16	395	6, 6a,
2,937	2,670	1,159	481	13.86	6.96	485	6b, 6c
3,004	2,767	1,226	578	14.87	4 52	554	7,
							10, 13
							8,
							11, 14
							9,
							12, 15

* Total value less cost of fertilizer.

how much more profitable is the crop from the use of the 50 pounds ration of nitrogen if the crop is to be sold, because, as previously stated, the market value of the crop depends on its weight, and not upon its protein content.

Effects upon Yields of Oats.— Only one soil test and two special nitrogen experiments were made with oats, a very much smaller number than were made with grasses and corn. At the time when these experiments were made the conditions of seasons and soil were not altogether favorable. For these reasons it is thought unadvisable to draw any definite conclusions regarding the effect of nitrogen upon the yields. It may be observed that, in a general way, the results seem to correspond with those with corn and grasses. There was a gradual increase in yield according to the increase in the quantity of nitrogen used, but the profits from the use of nitrogen have been very small. In the next section of the discussion, however, attention is called to the increase in the nitrogen compounds (protein) in the crop as a result of the use of nitrogen in the fertilizer.

The following table gives a comparison of the results of the experiments with oats. The yields per acre are the averages of yields from all the plots having the same kinds and amounts of fertilizer per acre.

TABLE 8.— *Comparison of yields of oats (grain) from plots upon which different quantities of nitrogen were used.*

Plot No.	Kinds and amounts of fertilizers per acre.	YIELD PER ACRE (ILL. % WATER).	
		Comparative scale, 400 lbs. to the inch.	lbs.
		lbs.	
0, 00, 000	{ Nothing, . . . .	.....	474
6, 6a,	{ Dissolved boneblack,	320	484
6b, 6c	{ Muriate of potash,	160	
7,	{ Mixed min. as plot 6,	420	586
10, 13	{ Nitrogen,	25	
8,	{ Mixed min. as plot 6,	480	633
11, 14	{ Nitrogen,	50	
9,	{ Mixed min. as plot 6,	480	704
12, 15	{ Nitrogen,	75	

EFFECT OF NITROGEN IN THE FERTILIZER UPON THE PRO-
TEIN OF THE CROP.

In most of the special nitrogen experiments and in a few of the soil test experiments, the effects of nitrogen of the fertilizers upon the composition of the crops have been studied by chemical analysis of samples taken in such a manner that they could be considered representative of the whole crop. The produce of each plot was weighed in the field at the time of harvesting, and the samples were gathered and weighed separately at that time. These samples were put into small bags, and were weighed again just before the analyses were made. From the results of the analyses, together with the weight of the sample and the total weight of the yield, it is possible to estimate not only the percentages of dry matter, nitrogen compounds (protein), and other ingredients, but also the total amounts of the several ingredients per acre. In the following discussion of the effects of nitrogenous fertilizers on the composition of the crop, tables are given showing both the percentage composition and the actual yields per acre calculated from the results of the analyses. The figures in these tables are averages of the results of all the similar experiments for all the years in which they were made. They are the figures given in bold faced type in the corresponding tables in the series at the end of the discussion. The tables there give the details of all the experiments in which analyses have been made; one set of tables gives the percentage composition of the crops analyzed, and the other set gives the yields per acre of nutrients calculated from the percentage composition and the weight of the crop.

Effect upon the Composition of Mixed Grasses.—In the experiments with mixed grasses the samples were taken while the hay was in the windrow, just before it was carted from the field. Large samples, from 12 to 20 pounds, were gathered into coarse sacks by taking small quantities from different parts of the plot. These samples were immediately cut into pieces one or two inches long, and mixed and sub-sampled, the final samples, from 3 to 5 pounds, being carefully weighed. In some instances duplicate, and in others triplicate samples were taken and analyzed separately, in order to prove the accuracy of the sampling. There were occasional slight variations in the composition of the different samples from the same plot, but the results on the whole were very uniform.

In some of these experiments with mixed grasses the results were affected considerably by the varying proportions of clover in the crops from the different plots. In the yields from all the plots to which nitrogen was applied the proportion of clover was so small that the results were not affected materially; but in the yields from plots (6a and 6b) upon which only mineral fertilizers were applied, the proportion of clover was large. Since clover is much richer in protein than the grasses, the percentage of protein in the crops from the mineral plots was proportionately much higher than the percentage in the crops from the nitrogen plots. In comparing the effects of the different fertilizers by the composition of the crops from the different plots this fact should be considered. In 1892, the third year of the experiment, the proportion of nitrogen compounds (protein) in the crop from the mineral plots was so large that it was thought best to make separate analyses of the entire crop and of the grasses. The results of analyses for that year show that the proportion of protein in the entire crop was 10.94 per cent., while in the grasses without the clover it was only 7.19 per cent. Accordingly the results from those plots

TABLE 9.—*Effects of nitrogenous fertilizers*

Plot No.	Kinds and amounts of fertilizers per acre.	No. of experiments,
	lbs.	
0, 00	Nothing,	3
6a, 6b	{ Dissolved boneblack, 320	3
	{ Muriate of potash, 160	
	{ Dissolved boneblack, 320	3
7	{ Muriate of potash, 160	
	{ Nitrate of soda (Nitrogen, 25 lbs.), . . . 160	3
	{ Dissolved boneblack, 320	
8	{ Muriate of potash, 160	3
	{ Nitrate of soda (Nitrogen, 50 lbs.), . . . 320	
	{ Dissolved boneblack, 320	3
9	{ Muriate of potash, 160	
	{ Nitrate of soda (Nitrogen, 75 lbs.), . . . 480	2
	{ Dissolved boneblack, 320	
10	{ Muriate of potash, 160	2
	{ Sulphate of ammonia (Nitrogen, 25 lbs.), . 120	
	{ Dissolved boneblack, 320	2
11	{ Muriate of potash, 160	
	{ Sulphate of ammonia (Nitrogen, 50 lbs.), . 240	2
	{ Dissolved boneblack, 320	
12	{ Muriate of potash, 160	2
	{ Sulphate of ammonia (Nitrogen, 75 lbs.), . 360	

have been omitted in computing the averages of analyses.

The following table shows the average percentages of the various food constituents in the hay of mixed grasses. The figures are those in bold face type in Table 25, page 162, giving details of the analyses of this crop for the three years.

From Table 9 it will be seen that the percentage of protein in the hay crop increased quite uniformly with the increase in the quantities of nitrogen in the fertilizers. For example, in the crops from the plots (6a and 6b) upon which the mineral fertilizers were used alone, the proportion of protein was 7.83 per cent.; in the crop from plot 7, with 25 pounds of nitrogen per acre in addition to the minerals, the proportion of protein was 7.95 per cent.; in the crop from plot 8, with 50 pounds of nitrogen per acre in the fertilizer, the proportion of protein was 8.46 per cent.; and in the crop from plot 9, to which 75 pounds of nitrogen per acre were applied, the proportion of protein was 9.42 per cent. It will be noticed also that the effect of the nitrogen in the fertilizer upon the proportion of protein in the crop was much the same, whether the nitrogen was supplied in nitrate of soda or in sulphate of ammonia.

upon the composition of hay of mixed grasses.

No. of analyses.	AVERAGE PERCENTAGE OF PROXIMATE CONSTITUENTS IN HAY, CALCULATED ON WATER-FREE SUBSTANCE.					Plot No.
	Protein.	Fat.	Nitrogen free extract.	✓ Fiber.	Ash.	
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	
9	7.29	3.67	52.62	31.44	4.98	0, 00
10	7.83	3.44	50.84	32.32	5.57	6a, 6b
5	7.95	3.62	49.62	33.36	5.45	7
5	8.46	3.65	48.56	34.09	5.24	8
5	9.42	3.68	47.96	33.64	5.30	9
4	7.50	3.60	49.94	33.62	5.34	10
4	8.46	4.29	48.51	33.40	5.34	11
4	9.36	3.82	48.68	32.91	5.23	12

In the following tabulation are shown the total yields of the various food ingredients, and the percentage difference between the yield of dry matter and of protein from the nitrogen plots and the unfertilized plots and that from the mineral plots. The figures given here are the averages given in bold face type in Table 26, page 164

From Table 10 it will be seen that the increase in the total yield of protein was relatively much larger than the increase in the total yield of dry matter. For if the yields from the plots upon which mineral fertilizers only were used be taken as a basis, the relative yields from the plots upon which 25, 50, and 75 pounds of nitrogen were used in addition to the minerals, were respectively as follows: of dry matter, 137, 177, and 188 per cent.; of protein, 127, 188, and 222 per cent. This brings out clearly the fact that the increase in the amount of protein obtained by the use of nitrogenous fertilizers is due not only to the increase in the total yield of the crop, but also to the higher percentages of protein in the composition of the crops from the plots upon which the larger quantities of nitrogen were used. For example, the yield of dry matter from the plot upon which 75 pounds of nitrogen were used was only 11 per cent. greater than the yield from the plot upon which 50 pounds were used; while the percentage of protein in the crop from the former plot was 34 per cent. greater than that in the crop from the latter plot; showing that the nitrogen in the fertilizer had a relatively greater tendency to increase the

TABLE 10. — *Effects of nitrogenous fertilizers upon yield of proximate percentages of yields of dry matter and protein from the*

Plot No.	Kinds and amounts of fertilizers per acre.						Number of experiments.
0, 00	Nothing,	lbs.	5
6a, 6b	{ Dissolved boneblack,	320	5
	{ Muriate of potash,	.	.	.	.	160
7, 10	{ Dissolved boneblack,	320	3
	{ Muriate of potash,	.	.	.	.	160
	{ Nitrogen,	.	.	.	.	25
8, 11	{ Dissolved boneblack,	320	3
	{ Muriate of potash,	.	.	.	.	160
	{ Nitrogen,	.	.	.	.	50
9, 12	{ Dissolved boneblack,	320	3
	{ Muriate of potash,	.	.	.	.	160
	{ Nitrogen,	.	.	.	.	75

proportion of protein in the crop than it had to increase the total yield of dry matter.

EFFECT UPON THE COMPOSITION OF DIFFERENT SPECIES OF GRASSES.

During the years 1891-98 a series of experiments, amounting to 32 in all, and comprising 114 plots, was carried on upon small plots in the grass garden, as noted on page 189. The plots usually included in the experiments were Nos. 0, 6, 7, and 9, according to the plan of special nitrogen experiments.* The nitrogen was usually supplied in nitrate of soda.

The size of the plots — 2 square rods — was so small that it seemed unadvisable to determine the total yields of the crop, hence the total yields of the food constituents could not be calculated. The percentages of the various food constituents in the crops were determined, however, by analyses of samples taken when the grass was in bloom, or in the early seed stage. The samples were gathered, weighed, cut, and sub-sampled as explained in the sampling of mixed grasses. The result of the experiments as shown by the percentages of protein, fat, etc., found in the crops from the different plots are given beyond in Table II. The figures of this table are the averages given in bold face type in Table 35, page 190, which gives the analyses of the crops for all the years in which experiments were made.

imate ingredients in hay of mixed grasses, with a comparison of the different plots on the basis of the yield from the mineral plots.

AVERAGE YIELDS OF PROXIMATE CONSTITUENTS OF HAY PER ACRE.						PERCENTAGE OF YIELD ON THE BASIS OF THE YIELD FROM THE MINERAL PLOTS.		Plot No.
Dry matter.	Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.	Dry matter.	Protein.	
lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	Per cent.	Per cent.	
1,675	121	61	882	527	83	71	62	0, 00
2,368	195	82	1,194	759	138	100	100	6a, 6b
3,240	248	116	1,619	1,082	175	137	127	7, 10
4,202	366	164	2,036	1,411	226	177	188	8, 11
4,458	432	169	2,148	1,470	242	188	222	9, 12

* See page 119.

TABLE II.—*Effect of nitrogenous fertilizers upon different species of grasses.*

Plot No.	Kinds and amounts of fertilizers per acre, and species of grass.	No. of experiments.	No. of analyses.	AVERAGE PERCENTAGE OF PROXIMATE CONSTITUENTS IN HAY, CALCULATED ON WATER-FREE SUBSTANCE.				
				Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
				Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
0	<i>Nothing.</i>							
	Timothy,	7	7	7.59	3.31	49.32	33.81	5.97
	Orchard grass,	7	7	8.13	3.98	45.52	34.18	8.19
	Tall meadow fescue grass,	5	5	7.16	3.01	46.41	36.30	7.12
	Tall red top,	2	2	6.89	3.22	52.49	30.46	6.94
	Tall meadow oat grass,	2	2	7.83	3.08	46.07	35.87	7.15
	Brome grass,	2	2	8.13	3.36	50.55	30.39	7.57
	Average of above species,			7.62	3.33	48.39	33.50	7.16
6	<i>Dissolved boneblack 320 lbs. Muriate of potash, 160 lbs. No nitrogen.</i>							
	Timothy,	7	7	7.03	2.94	50.14	33.49	6.40
	Orchard grass,	7	7	7.91	3.72	44.56	34.92	8.89
	Tall meadow fescue grass,	5	5	7.16	2.86	48.74	33.69	7.55
	Tall red top,	2	2	6.60	3.30	52.14	31.06	6.90
	Tall meadow oat grass,	2	2	7.50	3.14	44.99	36.80	7.57
	Brome grass,	2	2	8.17	3.35	50.52	29.34	8.62
	Average of above species,			7.39	3.22	48.52	33.22	7.65
7	<i>Dissolved boneblack 320 lbs. Muriate of potash 160 lbs. Nitrate of soda 160 lbs. (Nitrogen, 25 lbs.)</i>							
	Timothy,	7	7	7.32	3.04	47.88	35.75	6.01
	Orchard grass,	7	7	9.60	4.06	43.27	33.84	9.23
	Tall meadow fescue grass,	6	6	8.30	3.03	47.85	33.45	7.37
	Tall red top,	4	4	7.73	3.15	52.14	30.06	6.92
	Tall meadow oat grass,	3	3	9.97	3.26	44.88	34.81	7.08
	Brome grass,	2	2	8.72	3.39	50.16	30.23	7.50
	Fowl meadow grass,	1	1	12.06	3.28	42.30	32.84	9.52
	Kentucky blue grass,	1	1	12.88	4.04	44.89	31.49	6.70
	Rye grass,	1	1	10.87	2.71	50.79	27.54	8.09
	Average of above species,			9.72	3.33	47.13	32.22	7.60
9	<i>Dissolved boneblack 320 lbs. Muriate of potash 160 lbs. Nitrate of soda 480 lbs. (Nitrogen, 75 lbs.)</i>							
	Timothy,	7	7	9.30	3.26	47.42	34.13	5.89
	Orchard grass,	7	7	12.63	4.52	41.33	32.69	8.83
	Tall meadow fescue grass,	6	6	11.82	3.67	43.96	32.53	8.02
	Tall red top,	4	4	10.40	3.24	50.34	29.33	6.69
	Tall meadow oat grass,	3	3	12.40	3.45	43.11	33.81	7.23
	Brome grass,	2	2	12.97	4.06	43.93	31.54	7.50
	Fowl meadow grass,	1	1	14.87	2.83	42.25	31.65	8.40
	Kentucky blue grass,	1	1	15.44	4.51	43.49	29.62	6.94
	Rye grass,	1	1	12.62	2.92	48.69	27.71	8.06
	Average of above species,			12.49	3.61	44.95	31.44	7.51

It will be noticed that there are considerable differences in the proportions of protein in the different grasses grown under similar conditions. Of the three grasses, timothy, orchard grass, and meadow fescue, which have been under the experiment longest, orchard grass contained the largest proportion of protein on all the plots, and timothy the smallest on all the plots except the one without fertilizer. As observed on a later page, in the experiments with corn, the crops from the "nothing" plots usually contained a larger proportion of protein than the crop from some of the fertilized plots. This is doubtless accounted for, as in the experiments referred to, by the fact that where no fertilizers are used the crop ripens prematurely, in which case the amount of starch formed is less than in the matured crops, consequently the proportion of protein found is large.

In all cases, the lowest percentage of protein was found in the crops from the plots upon which only mineral fertilizers were used. The average proportion of protein for all the grasses from the mineral plots was 7.39 per cent.; from the plots upon which 25 pounds of nitrogen per acre was used, the average proportion of protein in all the grasses was 9.72 per cent.; from the plots upon which 75 pounds of nitrogen per acre was used the proportion of protein was 12.49 per cent. This means that, on the average, the grasses grown from the plots upon which the one-third ration of nitrogen was used in addition to the minerals were 32 per cent. richer in protein than those grown on the mineral plots; and the grasses grown on the plots upon which the full ration of nitrogen was used in addition to the minerals were nearly 70 per cent. richer in protein than those grown on the mineral plots. These experiments emphasize most forcibly the fact that great improvement can be made in the feeding value of our common grasses by the proper use of nitrogenous fertilizers.

Effect upon the Composition of Corn.—In the experiments with corn, samples of both the grain and the stover were taken separately for analysis. These were gathered at the time when the crop was weighed in the field, just before it was harvested. Large samples of the stover were gathered in much the same way as the samples of hay were taken. Small quantities of stover were taken from different parts of the plot, and were immediately cut into short lengths and sub-sampled. From 10 to 15 pounds of the ears were taken for samples; these were shelled and the weight of shelled corn in the samples was

immediately determined. These determinations served for computing the total yields per acre.

Early in these experiments it was noticed that there was a larger percentage of protein in the corn (seeds) from the plots upon which no fertilizer was used than there was in the corn from the fertilized plots. Later a probable cause of this difference was found in the large proportion of immatured kernels in the seed from the nothing plots; for a series of analyses of corn from several experiments, made so as to compare the

TABLE 12.—*Effects of nitrogenous fertilizers*

Plot No.	Kinds and amounts of fertilizers per acre.	No. of analyses.
	lbs.	
0, 00, 000	Nothing,	23
1 (and A)	Nitrate of soda,	9
2 (and B)	Dissolved boneblack,	10
3 (and C)	Muriate of potash,	10
4 (and D)	Dissolved boneblack,	9
	Nitrate of soda,	
5 (and E)	Muriate of potash,	9
	Nitrate of soda,	
6, 6a, 6b,	Dissolved boneblack,	20
6c (and F)	Muriate of potash,	
	Dissolved boneblack,	
7	Muriate of potash,	17
	Nitrate of soda (Nitrogen, 25 lbs.),	
	Dissolved boneblack,	
8	Muriate of potash,	10
	Nitrate of soda (Nitrogen, 50 lbs.),	
	Dissolved boneblack,	
9	Muriate of potash,	11
	Nitrate of soda (Nitrogen, 75 lbs.),	
	Dissolved boneblack,	
10	Muriate of potash,	6
	Sulphate of ammonia (Nitrogen, 25 lbs.),	
	Dissolved boneblack,	
11	Muriate of potash,	6
	Sulphate of ammonia (Nitrogen, 50 lbs.),	
	Dissolved boneblack,	
12	Muriate of potash,	6
	Sulphate of ammonia (Nitrogen, 75 lbs.),	
	Dissolved boneblack,	
13	Muriate of potash,	2
	Dried blood (Nitrogen, 25 lbs.),	
	Dissolved boneblack,	
14	Muriate of potash,	2
	Dried blood (Nitrogen, 50 lbs.),	
	Dissolved boneblack,	
15	Muriate of potash,	2
	Dried blood (Nitrogen, 75 lbs.),	

composition of the "good" corn — the hard, merchantable ears — with the "poor" corn — the soft ears and "nubbins," — showed that in the crops from all the plots the percentage of protein was higher in the "poor" corn than it was in the "good" corn. The reason for the higher percentage of protein in the immatured kernels appears to be that the normal amount of starch was not formed in them, while considerable protein was present, so that the amount of protein was relatively large. The seeds in crops from the nothing plots were

upon composition of corn (grain).

AVERAGE PERCENTAGE OF PROXIMATE CONSTITUENTS IN CORN (GRAIN) CALCULATED ON WATER FREE SUBSTANCE.					Plot No.
Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.	
Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	
11.15	5.43	80.06	1.64	1.73	0,00,000
11.92	5.31	79.40	1.69	1.68	1 (and A)
11.38	5.27	79.93	1.70	1.72	2 (and B)
10.49	5.21	80.97	1.68	1.65	3 (and C)
11.98	5.61	79.07	1.61	1.73	4 (and D)
11.11	5.43	80.68	1.59	1.71	5 (and E)
10.13	5.76	80.73	1.66	1.72	6, 6a, 6b, 6c (and F)
10.80	5.77	80.16	1.56	1.71	7
11.50	6.12	78.98	1.64	1.76	8
12.07	6.02	78.46	1.62	1.83	9
10.28	6.37	79.86	1.68	1.81	10
10.60	6.63	79.20	1.68	1.89	11
11.68	6.50	78.30	1.60	1.92	12
9.93	6.33	79.88	1.94	1.92	13
9.34	5.46	81.66	1.85	1.69	14
9.75	5.87	80.56	1.99	1.83	15

largely poor and immature, and, with the small proportions of starch, naturally contained a larger percentage of protein than the crops from the fertilized plots. For this reason the poor corn and "nubbins" were excluded when samples were being taken for analyses.

TABLE 13.—*Effects of nitrogenous*

Plot No.	Kinds and amounts of fertilizers per acre.	No. of analyses.
	lbs.	
0, 00, 000	Nothing,	23
1 (and A)	Nitrate of soda,	9
2 (and B)	Dissolved boneblack,	10
3 (and C)	Muriate of potash,	10
4 (and D)	Dissolved boneblack,	320
	Nitrate of soda (Nitrogen 25 lbs.),	160
5 (and E)	Muriate of potash,	160
	Nitrate of soda (Nitrogen 25 lbs.),	160
6a, 6b, 6c, (and F)	Dissolved boneblack,	320
	Muriate of potash,	160
	Dissolved boneblack,	320
7	Muriate of potash,	160
	Nitrate of soda (Nitrogen 25 lbs.),	160
	Dissolved boneblack,	320
8	Muriate of potash,	160
	Nitrate of soda (Nitrogen 50 lbs.),	320
	Dissolved boneblack,	320
9	Muriate of potash,	160
	Nitrate of soda (Nitrogen 75 lbs.),	480
	Dissolved boneblack,	320
10	Muriate of potash,	160
	Sulphate of ammonia (Nitrogen 25 lbs.),	120
	Dissolved boneblack,	320
11	Muriate of potash,	160
	Sulphate of ammonia (Nitrogen 50 lbs.),	240
	Dissolved boneblack,	320
12	Muriate of potash,	160
	Sulphate of ammonia (Nitrogen 75 lbs.),	360
	Dissolved boneblack, h.	320
13	Muriate of potash,	160
	Dried blood (Nitrogen 25 lbs.),	200
	Dissolved boneblack,	320
14	Muriate of potash,	160
	Dried blood (Nitrogen 50 lbs.),	400
	Dissolved boneblack,	320
15	Muriate of potash,	160
	Dried blood (Nitrogen 75 lbs.),	600

The analyses of the corn (grain) and the stover in these experiments are summarized in Tables 12 and 13. The figures in these tables are the averages given in bold face type in Tables 27 and 28, pages 166 and 171, which give the separate analyses of the several experiments.

fertilizers upon composition of corn stover.

AVERAGE PERCENTAGE OF PROXIMATE CONSTITUENTS IN CORN STOVER, CALCULATED ON WATER-FREE SUBSTANCE.					Plot No.
Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.	
Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	
6.91	1.84	50.76	34.30	6.19	0, 00, 000
7.74	1.96	50.95	33.97	5.38	1 (and A)
7.04	2.03	51.06	33.94	5.93	2 (and B)
6.40	2.15	51.42	33.76	6.27	3 (and C)
7.52	1.89	51.21	33.89	5.49	4 (and D)
6.72	1.99	50.40	34.67	6.22	5 (and E)
5.15	2.10	51.77	34.21	6.77	6a, 6b, 6c, (and F)
5.72	1.94	51.06	34.91	6.37	7
6.52	1.92	50.60	34.50	6.46	8
7.35	1.90	49.91	33.93	6.91	9
5.23	1.94	52.35	33.91	6.57	10
5.04	1.75	52.00	34.77	6.44	11
6.53	1.79	50.53	34.30	6.85	12
4.62	1.80	53.82	33.70	6.06	13
4.10	1.94	53.41	34.81	5.74	14
4.47	1.90	52.93	34.93	5.77	15

From table 12 it will be noticed that the percentage of protein in the grain from the nothing plots was higher than the percentage in the grain from many of the fertilized plots. This was doubtless due, as already suggested, to the large proportion of immatured or partially developed grain from these plots. The percentage of protein was lowest in the crops from the plots (6, 6a, 6b, 6c, F) upon which the mineral fertilizers were used without nitrogen.

By comparing the results of the experiments with mixed minerals alone and those with nitrogen in addition it will be noticed that there was a gradual increase in the proportion of

TABLE 14.—*Effects of nitrogenous fertilizers upon yields of proximate yields from the nothing plot and from the different plots*

Plot No.	Kinds and amounts of fertilizers per acre.	No. of experiments.	Material.
	lbs.		
0, 00, 000.	{ Nothing,	13	Grain
	...	13	Stover
			Total
1 (and A)	{ Nitrate of soda,	7	Grain
	...	7	Stover
			Total
2 (and B)	{ Dissolved boneblack,	8	Grain
	...	8	Stover
			Total
3 (and C)	{ Muriate of potash,	8	Grain
	...	8	Stover
			Total
4 (and D)	{ Dissolved boneblack,	7	Grain
	{ Nitrate of soda,	7	Stover
			Total
5 (and E)	{ Nitrate of soda,	7	Grain
	{ Muriate of potash,	7	Stover
			Total
6, 6a, 6b,	{ Dissolved boneblack,	13	Grain
6c (and F)	{ Muriate of potash,	13	Stover
			Total
7, 10, 13,	{ Dissolved boneblack,	13	Grain
	{ Muriate of potash,	13	Stover
	{ Nitrogen,	25	Total
	{ Dissolved boneblack,	9	Grain
8, 11, 14,	{ Muriate of potash,	9	Stover
	{ Nitrogen,	50	Total
	{ Dissolved boneblack,	9	Grain
9, 12, 15,	{ Muriate of potash,	9	Stover
	{ Nitrogen,	75	To ta

protein in the corn, corresponding to the increase in the amount of nitrogen in the fertilizer. Thus in the experiments with nitrate of soda as the source of nitrogen the proportions of protein were as follows: in the corn from the mineral plots, 10.13 per cent.; from the plots with 25 pounds of nitrogen, 10.80 per cent.; from the plots with 50 pounds of nitrogen, 11.50 per cent.; from the plots with 75 pounds of nitrogen, 12.07 per cent. In the experiments in which sulphate of ammonia was the source of nitrogen there was likewise an increase in the protein with the increase in the nitrogen supplied, but the proportion of protein was not quite so large as in the

mate ingredients of corn (grain) and stover, with a comparison of the having nitrogen with the yield from the mineral plot.

AVERAGE YIELD OF PROXIMATE CONSTITUENTS OF CORN (GRAIN) AND CORN STOVER PER ACRE.						PERCENTAGE OF YIELD ON THE BASIS OF YIELD FROM MINERAL PLOT.		Plot No.
Dry matter.	Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.	Dry matter.	Protein.	
lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	Per cent.	Per cent.	
1,064	118	61	851	17	18	67	74	0,00,000.
1,264	86	23	641	435	78	67	92	
2,328	204	84	1,492	452	96	67	81	
1,123	131	60	897	18	18	71	82	1 (and A)
1,233	91	24	630	421	67	65	99	
2,356	222	84	1,527	439	85	68	88	
893	102	48	715	14	15	57	64	2 (and B)
1,168	76	24	598	399	70	62	82	
2,061	178	72	1,313	413	85	60	70	
1,093	116	58	883	18	18	69	73	3 (and C)
1,321	84	29	683	444	81	70	90	
2,414	200	87	1,566	462	99	70	79	
1,267	153	72	1,002	20	22	80	96	4 (and D)
1,417	105	26	726	482	76	75	113	
2,684	258	98	1,728	502	98	78	102	
1,606	187	92	1,361	27	27	107	116	5 (and E)
1,589	102	32	805	555	96	85	110	
3,285	289	124	2,166	582	123	95	114	
1,580	160	92	1,274	26	27	100	100	6, 6a, 6b, 6c (and F)
1,876	93	39	980	637	126	100	100	
3,456	253	131	2,254	663	153	100	100	
2,132	228	127	1,706	33	37	135	143	7, 10, 13,
2,149	118	41	1,100	750	139	115	127	
4,281	346	168	2,806	783	176	124	137	
2,611	290	165	2,068	42	47	165	181	8, 11, 14,
2,271	136	45	1,157	786	149	121	146	
4,882	426	210	3,225	828	196	141	168	
2,670	320	166	2,094	42	49	168	200	9, 12, 15,
2,372	166	43	1,184	814	165	126	178	
5,042	486	209	3,278	856	214	146	192	

experiments in which nitrate of soda was used. The proportions of protein were, with 25 pounds of nitrogen in sulphate of ammonia, 10.28 per cent.; with 50 pounds of nitrogen, 10.60 per cent.; with 75 pounds of nitrogen, 11.68 per cent. In the experiments in which dried blood was used as a source of nitrogen, the increase in the proportions of protein did not correspond to the quantities of nitrogen used. But as only two such experiments were made, the results should not be compared too closely with those of a larger number of experiments in which other fertilizing materials were used.

TABLE 15.—*Effect of nitrogenous fertilizers*

Plot No.	Kinds and amounts of fertilizers per acre.	No. of experiments.
	lbs.	
0, 00, 000	Nothing,	3
1 (and A)	Nitrate of soda,	2
2 (and B)	Dissolved boneblack,	2
3 (and C)	Muriate of potash,	2
4 (and D)	{ Dissolved boneblack, 320 } Nitrate of soda, 160 }	2
5 (and E)	{ Muriate of potash, 160 } Nitrate of soda, 160 }	2
6, 6a, .	{ Dissolved boneblack, 320 } Muriate of potash, 160 }	3
6b (and F)	{ Dissolved boneblack, 320 } Muriate of potash, 160 }	2
7	{ Nitrate of soda (Nitrogen, 25 lbs.), 160 } Dissolved boneblack, 320 }	2
8	{ Muriate of potash, 160 } Nitrate of soda (Nitrogen, 50 lbs.), 320 }	2
9	{ Dissolved boneblack, 320 } Muriate of potash, 160 }	2
10	{ Nitrate of soda (Nitrogen, 75 lbs.), 480 } Dissolved boneblack, 320 }	1
11	{ Muriate of potash, 160 } Sulphate of ammonia (Nitrogen, 25 lbs.), 120 }	1
12	{ Dissolved boneblack, 320 } Muriate of potash, 160 }	1
13	{ Sulphate of ammonia (Nitrogen, 50 lbs.), 240 } Dissolved boneblack, 320 }	1
14	{ Muriate of potash, 160 } Sulphate of ammonia (Nitrogen, 75 lbs.), 360 }	2
15	{ Dissolved boneblack, 320 } Muriate of potash, 160 }	2
	{ Dried blood (Nitrogen, 25 lbs.), 200 } Dissolved boneblack, 320 }	2
	{ Muriate of potash, 160 } Dried blood (Nitrogen, 50 lbs.), 400 }	2
	{ Dissolved boneblack, 320 } Muriate of potash, 160 }	2
	{ Dried blood (Nitrogen, 75 lbs.), 600 }	2

In the Table 14 are shown the total and the relative yield per acre of the various food constituents in the corn and stover. The figures in this table are the averages in bold face type in tables 29 and 30, pages 176 and 179, which give the type in Tables 29 and 30, pages 176 and 179, which give the separate analyses of the several experiments with corn.

From this table it will be observed that the nitrogenous fertilizers had a relatively more marked effect upon the yields of protein than upon the yields of dry matter. Thus, in the grain, the total yield of dry matter with the use of 75 pounds of nitrogen per acre was only slightly larger than the yield from

upon the composition of oats (grain).

No. of analyses.	AVERAGE PERCENTAGE OF PROXIMATE CONSTITUENTS IN OATS (GRAIN), CALCULATED ON WATER-FREE SUBSTANCE.					Plot No.
	Protein.	Fat.	Nitrogen / free extract.	Fiber.	Ash.	
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	
11	14.22	5.88	65.79	10.74	3.37	0, 00, 000
2	15.08	6.10	66.94	8.56	3.32	1 (and A)
2	13.25	6.04	67.88	9.23	3.60	2 (and B)
2	13.71	6.02	67.79	9.08	3.40	3 (and C)
2	13.68	6.21	68.84	8.15	3.12	4 (and D)
2	14.46	6.15	67.50	8.73	3.17	5 (and E)
8	14.76	6.10	67.03	8.99	3.12	6, 6a, 6b (and F)
4	14.68	6.01	67.39	8.96	2.96	7
2	16.34	5.79	65.08	9.97	2.82	8
2	16.97	5.68	63.93	10.55	2.87	9
1	13.94	6.05	64.90	12.25	2.86	10
1	15.12	6.14	64.45	11.59	2.70	11
1	15.00	5.86	62.38	13.84	2.92	12
2	15.00	5.84	65.79	10.39	2.98	13
2	14.97	5.81	65.77	10.55	2.90	14
2	15.87	5.95	65.70	9.67	2.81	15

the use of 50 pounds, while the yield of protein with 75 pounds of nitrogen was considerably increased over the yield with 50 pounds. This is shown quite clearly by the last two columns of the tables, which compare the yield from the different nitrogen plots with the yield from the mineral plots. The yield of dry matter with 25 pounds of nitrogen was 35 per cent. greater than that from the mineral plots; the yield with 50 pounds of nitrogen was 65 per cent. greater, while the yield with 75 pounds of nitrogen was only 68 per cent. greater than the yield from the mineral plots; but for the same series of plots the increase in the proportion of protein from the use of nitrogen was 43, 81, and 100 per cent. respectively.

TABLE 16.—*Effects of nitrogenous fertilizers*

Plot No.	Kinds and amounts of fertilizers per acre.	No. of experiments.
	lbs.	
0, 00, 000	Nothing,	3
6, 6a	{ Dissolved boneblack, 320	3
6b, 6c	{ Muriate of potash, 160	
	{ Dissolved boneblack, 320	
7	{ Muriate of potash, 160	2
	{ Nitrate of soda (Nitrogen, 25 lbs.), . . . 160	
	{ Dissolved boneblack, 320	2
8	{ Muriate of potash, 160	
	{ Nitrate of soda (Nitrogen, 50 lbs.), . . . 320	
	{ Dissolved boneblack, 320	2
9	{ Muriate of potash, 160	
	{ Nitrate of soda (Nitrogen, 75 lbs.), . . . 480	
	{ Dissolved boneblack, 320	1
10	{ Muriate of potash, 160	
	{ Sulphate of ammonia (Nitrogen, 25 lbs.), . 120	
	{ Dissolved boneblack, 320	1
11	{ Muriate of potash, 160	
	{ Sulphate of ammonia (Nitrogen, 50 lbs.), . 240	
	{ Dissolved boneblack, 320	1
12	{ Muriate of potash, 160	
	{ Sulphate of ammonia (Nitrogen, 75 lbs.), . 360	
	{ Dissolved boneblack, 320	2
13	{ Muriate of potash, 160	
	{ Dried blood (Nitrogen, 25 lbs.), . . . 200	
	{ Dissolved boneblack, 320	2
14	{ Muriate of potash, 160	
	{ Dried blood (Nitrogen, 50 lbs.), . . . 400	
	{ Dissolved boneblack, 320	2
15	{ Muriate of potash, 160	
	{ Dried blood (Nitrogen, 75 lbs.), . . . 400	

Effect upon the Composition of Oats. — The two special nitrogen experiments with oats comprised 26 plots upon which nitrogen was applied in nitrate of soda, sulphate of ammonia, and dried blood. As in the experiments with corn, samples of both the grain and the straw without the grain were gathered when the crop was harvested, and were carefully prepared for analysis. With the data from these analyses, given in Tables 15 and 16, are included also some of the results of analyses of grain from the soil test experiment. The figures given in these tables are the averages in bold face type in Tables 31 and 32 on pages 182 and 185.

upon composition of oat straw.

No. of analyses.	AVERAGE PERCENTAGE OF PROXIMATE CONSTITUENTS IN OAT STRAW CALCULATED ON WATER-FREE SUBSTANCE.					Plot No.
	Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.	
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	
5	7.39	3.36	47.40	36.84	5.01	0, 00, 000 6, 6a 6b, 6c
6	5.04	3.05	46.41	39.95	5.55	
2	4.63	3.16	46.44	40.65	5.12	
2	4.90	2.95	46.47	40.60	5.08	7
2	6.03	2.97	45.39	40.23	5.38	8
1	5.69	3.60	49.56	36.61	4.54	9
1	6.81	3.38	48.66	37.00	4.15	10
1	7.50	3.18	48.15	37.05	4.12	11
2	4.75	3.01	46.52	40.75	4.97	12
2	4.82	2.95	47.13	40.02	5.08	13
2	5.27	3.04	47.53	39.37	4.79	14
						15

In the discussion of the effect of nitrogenous fertilizers upon the yields of oats, on a previous page, reference was made to the fact that the number of experiments was smaller than that with some of the other crops, and that the conditions of soil and season were unfavorable. For this reason only general conclusions were drawn from the results of the experiments. The same facts should be taken into account in considering the effects of nitrogen of the fertilizers upon the composition of the crop. In a brief discussion of the data of Table 14 it may be observed that, as noticed in experiments with other crops, the proportion of protein in the grain from the "nothing" plots is larger than that in the grain from some of the fertilized plots. In the grain from the mineral plots there was 14.76 per cent. of protein. With 25 pounds of nitrogen per acre in addition to the minerals there was practically the same proportion of protein, 14.68 per cent. With 50 pounds of nitrogen per acre the grain had 16.34 per cent. of protein, a considerable increase, while with 75 pounds of nitrogen per acre it was 16.97 per cent., a still further increase, although not so large as be-

TABLE 17.—*Effects of nitrogenous fertilizers upon yield of proximate centages of yield from the different plots on*

Plot No.	Kinds and amounts of fertilizers per acre.		No. of experiments.	Material.
		lbs.		
0, 00, 000	{ Nothing, . . . . .	...	8	Grain
		...	5	Straw
		...	..	Total
6, 6a, 6b, 6c	{ Dissolved boneblack,	320	6	Grain
		Muriate of potash,	160	6
		...	..	Total
7, 10, 13	{ Dissolved boneblack,	320	2	Grain
		Muriate of potash,	160	2
		Nitrogen,	25	..
8, 11, 14	{ Dissolved boneblack,	320	2	Grain
		Muriate of potash,	160	2
		Nitrogen,	50	..
9, 12, 15	{ Dissolved boneblack,	320	2	Grain
		Muriate of potash,	160	2
		Nitrogen,	75	..
				Total

fore in proportion to the increase in nitrogen. These are the results from the use of nitrogen in nitrate of soda. There was less gain in the proportion of protein in the grain following the use of nitrogen in sulphate of ammonia, and still less from the use of organic nitrogen in dried blood.

A somewhat similar discussion might apply to the figures in Table 16, showing the effect of nitrogen upon the straw without the grain. From this table, however, it appears that the largest gains and more uniform increase in protein resulted from the use of sulphate of ammonia.

The following table shows the effect of nitrogenous fertilizers upon oats by a comparison of the calculated yields of dry matter and of protein in the crops. The figures given here are the averages in bold face type found in Tables 33 and 34 on pages 187 and 188.

It will be noticed here also, as has been mentioned in the discussion of results with other crops, that the yields of dry matter increased gradually with the increase of the quantities of nitrogen used in the fertilizers; but the protein increased much more rapidly.

*ingredients of oats (grain) and oat straw, with a comparison of per-
the basis of the yield from the mineral plots.*

AVERAGE YIELDS OF PROXIMATE CONSTITUENTS OF OATS (GRAIN) AND OAT STRAW PER ACRE.						PERCENTAGE OF YIELD ON THE BASIS OF THE YIELD FROM THE MINERAL PLOTS.		Plot No.
Dry matter.	Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.	Dry matter.	Protein.	
lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	Per cent.	Per cent.	
421	64	25	277	41	15	98	95	
545	33	18	251	213	31	59	75	0, 00, 000
966	97	43	528	254	46	72	88	
430	67	27	287	36	13	100	100	6, 6a, 6b, 6c
910	44	27	422	373	53	100	100	
1349	111	54	709	409	66	100	100	
521	82	32	344	49	16	121	122	
1264	57	38	580	523	66	138	130	7, 10, 13
1785	139	70	924	572	82	132	125	
563	90	33	367	57	16	131	134	
1461	71	42	673	508	77	159	161	8, 11, 14
2024	161	75	1040	655	93	150	145	
626	103	36	405	65	18	146	154	
1901	112	54	870	767	99	207	255	9, 12, 15
2527	215	90	1275	832	117	187	194	


EFFECT OF NITROGENOUS FERTILIZERS UPON LEGUMES.

During the years 1895-98 inclusive, the Station carried on a series of experiments with several of the legumes, especially cow peas and soy beans. With each crop there were four experiments, comprising 10 plots each, mostly small. Although there were fewer and less extensive experiments with these crops than with cereals and grasses, the results are interesting and important.

Effect upon Yield. — The experiments, on the whole, indicate that the yields of legumes were increased only slightly, if at all, by the use of nitrogenous fertilizers. In many cases the yields with mineral fertilizers were nearly or quite as large as those from the use of nitrogen in addition to the minerals. This was especially noticeable, as seen in Table 18, in the experiments with cow peas grown for fodder, and harvested before or at time of blossom. In these experiments only the plots to which the one-third ration of nitrogen was added yielded crops larger than those from the mineral plots.

The weights of yields per acre given in the following table represent the averages of yields from the plots upon which the same kinds and amounts of fertilizers were used.










TABLE 18.— *Comparison of yields of cow peas (green plants cut for fodder) from plots upon which different quantities of nitrogen were used.*

Plot No.	Kinds and amounts of fertilizers per acre.	YIELD PER ACRE (80 % WATER).	
		Comparative scale, 10,000 lbs. to the inch.	lbs.
0, 00	Nothing,		9660
6a, 6b	{ Dissolved boneblack, . . .	320	18485
	{ Muriate of potash, . . .	160	
7, 10	{ Mixed min. as plot 6, . . .	480	19265
	{ Nitrogen,	25	
8, 11	{ Mixed min. as plot 6, . . .	480	18465
	{ Nitrogen,	50	
9, 12	{ Mixed min. as plot 6, . . .	480	18100
	{ Nitrogen,	75	

From this table it will be seen that not only was there no increase from the use of nitrogen, but even the yields of the crops from the use of the larger amounts of nitrogen averaged less than those from the use of minerals only.

The following table gives a comparison of the averages of yields of soy beans (seeds) from the different plots upon which the same kinds and amounts of fertilizers were used.

TABLE 19.—*Comparison of yields of soy beans (seeds) from plots upon which different quantities of nitrogen were used.*

Plot No.	Kinds and amounts of fertilizers per acre.	YIELD PER ACRE (11 % WATER).	
		Comparative scale, 450 lbs. to the inch.	lbs.
0, 00	Nothing,		458
6a, 6b	{ Dissolved boneblack, . . .		680
	{ Muriate of potash, . . .		
7, 10	{ Mixed min. as plot 6, . . .		696
	{ Nitrogen,		
8, 11	{ Mixed min. as plot 6, . . .		784
	{ Nitrogen,		
9, 12	{ Mixed min. as plot 6, . . .		794
	{ Nitrogen,		

From this table it is noticed that there was some slight increase in the yield of the soy bean crop following the use of nitrogenous fertilizers, but it was not sufficient to make their use at all economical for this crop.

Soy beans and cow peas are not commonly found in our markets; consequently it is difficult to estimate their market value. For this reason, and because of the small size of the plots and the small number of experiments conducted, it has been thought best not to attempt to estimate the financial gains.

Effect upon the Composition.—The composition of the legumes was determined by analyses of samples carefully gathered in much the same manner as described in the sampling of other crops. Only the seeds of the soy beans were analyzed, because, as already explained (page 116), it was found impracticable to take representative samples of the whole plant. Although the total number of analyses of these crops is not large, yet the results of all of them appear to indicate that nitrogen added to the fertilizer does not tend to increase very largely the proportion of nitrogen compounds (protein) found in the crop. This is shown in the following tables, which give the average composition of the cow pea fodder and of the soy beans from all plots having uniform quantities of mineral fertilizers with different quantities of nitrogen. The figures in these tables are the averages given in bold face type in Tables 36 and 38, pages 197 and 201.

TABLE 20.—*Effect of nitrogenous fertilizers upon the*

Plot No.	Kinds and amounts of fertilizers per acre.	No. of experiments.
	lbs.	
0, 00, 000	Nothing,	5
6a, 6b	{ Dissolved boneblack, 320	6
	{ Muriate of potash, 160	
	{ Dissolved boneblack, 320	
7	{ Muriate of potash, 160	6
	{ Nitrate of soda (Nitrogen, 25 lbs.), 160	
	{ Dissolved boneblack, 320	
8	{ Muriate of potash, 160	4
	{ Nitrate of soda (Nitrogen, 50 lbs.), 320	
	{ Dissolved boneblack, 320	
9	{ Muriate of potash, 160	6
	{ Nitrate of soda (Nitrogen, 75 lbs.), 480	
	{ Dissolved boneblack, 320	
10	{ Muriate of potash, 160	4
	{ Sulphate of ammonia (Nitrogen, 25 lbs.), 120	
	{ Dissolved boneblack, 320	
11	{ Muriate of potash, 160	4
	{ Sulphate of ammonia (Nitrogen, 50 lbs.), 240	
	{ Dissolved boneblack, 320	
12	{ Muriate of potash, 160	4
	{ Sulphate of ammonia (Nitrogen, 75 lbs.), 360	

TABLE 21.—*Effect of nitrogenous fertilizers*

Plot No.	Kinds and amounts of fertilizers per acre.	No. of experiments.
	lbs.	
0, 00	Nothing,	3
6a, 6b	{ Dissolved boneblack, 320	4
	{ Muriate of potash, 160	
	{ Dissolved boneblack, 320	
7	{ Muriate of potash, 160	4
	{ Nitrate of Soda (Nitrogen, 25 lbs.), 160	
	{ Dissolved boneblack, 320	
8	{ Muriate of potash, 160	3
	{ Nitrate of soda (Nitrogen, 50 lbs.), 320	
	{ Dissolved boneblack, 320	
9	{ Muriate of potash, 160	4
	{ Nitrate of soda (Nitrogen, 75 lbs.), 480	
	{ Dissolved boneblack, 320	
10	{ Muriate of potash, 160	3
	{ Sulphate of ammonia (Nitrogen, 25 lbs.), 120	
	{ Dissolved boneblack, 320	
11	{ Muriate potash, 160	3
	{ Sulphate of ammonia (Nitrogen, 50 lbs.) 240	
	{ Dissolved boneblack, 320	
12	{ Muriate of potash, 160	3
	{ Sulphate of ammonia (Nitrogen, 75 lbs.), 360	

composition of cow peas (plants grown for fodder).

No. of analyses.	AVERAGE PERCENTAGE OF PROXIMATE CONSTITUENTS IN COW PEA FODDER, CALCULATED ON WATER-FREE SUBSTANCE.					Plot No.
	Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.	
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	
12	18.38	3.57	44.67	21.76	11.62	0, 00, 000
10	18.37	3.18	44.32	23.47	10.96	6a, 6b
7	17.90	3.41	44.27	23.25	11.17	7
4	18.20	3.11	44.82	24.11	9.79	8
6	18.96	3.72	44.55	22.11	10.66	9
4	18.17	3.24	44.17	23.63	10.79	10
4	17.18	3.29	46.01	22.90	10.62	11
4	19.32	3.05	43.48	22.96	11.19	12

upon the composition of soy bean seed.

No. of analyses.	AVERAGE PERCENTAGE OF PROXIMATE CONSTITUENTS IN SOY BEAN SEED, CALCULATED ON WATER-FREE SUBSTANCE.					Plot No.
	Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.	
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	
6	39.96	19.00	29.32	4.50	7.22	0, 00
7	39.30	20.01	30.77	3.92	6.00	6a, 6b
4	39.87	19.75	30.43	3.94	6.00	7
3	40.69	20.00	29.28	4.20	5.83	8
4	41.61	19.56	29.35	3.87	5.61	9
3	39.99	20.59	29.76	3.88	5.78	10
3	40.73	20.54	29.57	3.57	5.59	11
3	41.33	20.16	28.38	3.87	6.26	12

From the results given in these tables it would seem that there is very little relationship between the quantities of nitrogen used in the fertilizer and the percentages of protein found in the crop. The percentage of protein in the crops from the plots upon which only mineral fertilizers were used is about as high as that in the crops from the plots to which nitrogen was applied in addition to the minerals. In the case of the cow pea as cut for fodder (see Table 20) the only noticeable increase in the percentage of protein was found in the crops from the plots upon which 75 pounds of nitrogen per acre was used. In the case of the soy beans, however (see Table 21), it appears that the nitrogen of the fertilizer had a little more effect upon the composition of the crop; for there is a difference in the percentage of protein in the crops from the different plots, a small increase corresponding fairly regularly to the increase in the quantities of nitrogen in the fertilizers used. In the crops from the plots upon which the full ration of nitrogen was applied in nitrate of soda the percentage of protein was 2.3 per cent. higher than that in the crops from the plots upon which only the minerals were used. Similarly, a small gain in the protein of this crop may be noticed when sulphate of ammonia is the source of nitrogen in the fertilizer.

The total yields of dry matter and of protein per acre in the cow pea fodder and soy beans are given in the following tables. The weights of the yields given are the averages in bold face type found in Tables 37 and 39, pages 199 and 203.

TABLE 22.— *Effects of nitrogenous fertilizers upon cow peas grown for fodder, with a comparison of percentages of yields of dry matter and protein from the different plots on the basis of the yield from the mineral plots.*

Plot No.	Kinds and amounts of fertilizers per acre.		No. of experiments.	AVERAGE YIELDS OF PROXIMATE CONSTITUENTS OF COW PEA FODDER PER ACRE.							PERCENTAGE OF YIELD ON BASIS OF THE YIELD FROM MINERAL PLOTS.	
				Dry matter.	Protein.	Fat.	Nitrogen-free extract.	Fiber.	Ash.		Dry matter.	Protein.
		lbs.		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.		Per ct.	Per ct.
0, 00	Nothing,	.....	4	1,932	344	68	880	429	211		52	52
6a, 6b	{ Dissolved boneblack,	320	4	3,697	666	113	1,661	873	384		100	100
	{ Muriate of potash, .	160										
7, 10	{ No nitrogen, .	...	4	3,853	666	118	1,768	916	385		104	100
	{ Dissolved boneblack,	320										
8, 11	{ Muriate of potash, .	160	4	3,693	675	118	1,640	873	387		100	101
	{ Nitrogen, .	25										
9, 12	{ Dissolved boneblack,	320	4	3,620	665	119	1,648	817	371		98	100
	{ Muriate of potash, .	160										
	{ Nitrogen, .	75										

TABLE 23.— *Effects of nitrogenous fertilizers upon soy beans (seeds), with a comparison of the yields of dry matter and protein from the different plots on the basis of the yield from the mineral plots.*

Plot No.	Kinds and amounts of fertilizers per acre.		No. of experiments.	AVERAGE YIELDS OF PROXIMATE CONSTITUENTS OF SOY BEAN (SEEDS) PER ACRE.							PERCENTAGE OF YIELD ON BASIS OF YIELD FROM MINERAL PLOTS.	
				Dry matter.	Protein.	Fat.	Nitrogen-free extract.	Fiber.	Ash.		Dry matter.	Protein.
		lbs.		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.		Per cent.	Per cent.
0, 00	Nothing,	.....	3	412	165	80	117	16	34		67	68
6a, 6b	{ Dissolved boneblack,	320	3	612	241	128	183	22	38		100	100
	{ Muriate of potash, .	160										
7, 10	{ No nitrogen, .	...	3	626	252	130	184	22	38		102	105
	{ Dissolved boneblack,	320										
8, 11	{ Muriate of potash, .	160	3	706	288	147	206	24	41		115	120
	{ Nitrogen, .	25										
9, 12	{ Dissolved boneblack,	320	3	715	297	146	203	26	43		117	123
	{ Muriate of potash, .	160										
	{ Nitrogen, .	50										

From the tables it will be seen that the yields of both dry matter and protein in the cow pea fodder remain nearly uniform without regard to the quantities of nitrogen in the fertilizer used. This is shown most plainly by the columns giving the percentage of yields. The basis taken for comparison and for computation of percentages is the yield from the plots supplied with the mineral fertilizers alone. Taking these yields at 100 per cent., the largest yield of cow pea fodder from any of the nitrogen plots reaches only 104 per cent. for dry matter and 101 per cent. for protein; while the largest yield of soy beans was 117 per cent. of dry matter and 123 per cent. of protein.

The results of the experiments with legumes are in striking contrast to those of experiments with grasses. This is shown clearly by the table on page 158, comparing results in dry matter and protein from experiments with all the crops. The maximum increase in yield from the plots where the largest ration of nitrogen was used, over that from plots where only mineral fertilizers were used, was 17 per cent. of dry matter and 23 per cent. of protein in the soy beans, compared with 88 per cent. of dry matter and 122 per cent. of protein in the grasses.

The contrast thus shown between the grasses and the legumes in regard to the effect of nitrogenous fertilizers is of economical importance to the farmer. It is greatly to his advantage to know that nitrogenous fertilizers applied to grasses like timothy, red top, etc., increase not only the total yield of crop, but also, in a relatively greater proportion, the percentage of protein in the crop; while the same kinds and amounts of nitrogenous fertilizers have little or no effect upon either the total yield or the percentage of protein in such crops as clover, alfalfa, vetches, cow pea, soy beans, etc.

On the other hand, the fact that the legumes, as shown by the experiments reported, can be grown advantageously by the use of no other fertilizers than the mixed minerals is also of very great practical importance. These crops are rich in protein, but the nitrogen for its formation they take largely from the air, instead of drawing heavily upon that in the soil, as do the grasses and cereals. Thus by growing the leguminous crops, and by practising a judicious system of rotation, the farmer may increase greatly the amount of protein produced upon the farm, and at the same time conserve the fertility of the soil.

SUMMARY OF EXPERIMENTS AND RESULTS.

Summary. — The experiments on the effects of nitrogenous fertilizers were undertaken for the study of two problems: first, the relative economy of the use of nitrogen in different amounts and combinations in the production of grasses, grains, and legumes; and second, the effect of the nitrogen of the fertilizer on the proportion of nitrogen compounds (protein) in the crop. These experiments have been made on the Station farm, and on a large number of farms throughout the State.

The experiments were of two kinds, called "special nitrogen" and "soil test" experiments. The number of soil test experiments in which chemical analyses of samples were made was quite limited, but the results have been incorporated with those from the special nitrogen experiments whenever it was thought that they would add to the general value of the work.

The experiments here reported consisted, first, of special nitrogen field experiments upon mixed grasses, corn, oats, cow peas, and soy beans; and second, of a modified form of the same class of experiments, conducted on small plots with distinct species of grasses; and third, of a small number of soil test experiments with corn and oats.

The special nitrogen field experiments were conducted upon a series of plots, all of which, except two without any fertilizer, were treated with uniform quantities of mineral fertilizer (phosphoric acid and potash). In addition to the mineral fertilizer different materials supplying nitrogen were used in varying amounts, sufficient to furnish 25, 50, and 75 pounds of nitrogen per acre. The materials in which nitrogen was supplied were nitrate of soda and sulphate of ammonia, and in a few cases dried blood. The plots were generally from one-tenth to one-twentieth acre each. All in a given experiment were of the same size.

The experiments on distinct species of grasses were conducted, in most cases, upon plots one-eightieth of an acre in size, and were similar to the special nitrogen field experiments except that lack of space prevented the use of so many plots. The plots used were those receiving no fertilizer, those receiving mineral fertilizers only, and those receiving mineral fertilizers plus nitrogen at the rate of 25 and 75 pounds per acre.

The soil test experiments were undertaken primarily to study the fertilizer requirements of different soils and crops. They were generally laid out on a series of plots of from one-

tenth to one-twentieth acre each, to which were applied the various fertilizer ingredients (nitrogen, phosphoric acid, and potash) singly, two by two, and all three together.

Results. — The experiments in which dried blood was used as a source of nitrogen were so few that no deductions from the yield of the crop can be made concerning the economy in using this material for fertilizer. From the experiments with the other materials supplying nitrogen it would appear that there was more advantage in the use of nitrate of soda than in the use of sulphate of ammonia. This was due rather to the higher cost of the sulphate of ammonia than to its lower efficiency as a fertilizer, although slightly larger yields were usually obtained on the plots where nitrate of soda was used.

In the experiments with mixed grasses it was found that nitrogen in the fertilizer increased very considerably the yield of hay, and also to a marked degree the proportion of nitrogen compounds (protein) in the crop, especially where the larger quantities of nitrogen were used. Thus the use of nitrogen proved to be economical as affecting the amounts and consequently the commercial value of the crop, and still further so affecting the feeding value. On the whole, the most economical returns were made by the plots containing nitrate of soda at the rate of 320 pounds (nitrogen 50 pounds) per acre.

In the experiments with corn the efficiency of nitrogen in the fertilizer in increasing the yield of the crop was not so marked as it was in the experiments with mixed grasses. While in the experiment on the grasses the yield from the use of 75 pounds of nitrogen per acre was considerably greater than the yield from the use of 50 pounds, in the experiments on corn the average yield with 75 pounds was very little more than with the use of 50 pounds of nitrogen per acre. In these experiments the most economical results were from the plots upon which 160 pounds of nitrate of soda (25 pounds of nitrogen) were used. These results seem to indicate that, in the use of fertilizers on corn, under such conditions as those in these experiments, the most economical amount of nitrogen ranges between 25 and 40 pounds per acre (equal to 160 to 250 pounds of nitrate of soda). In all the experiments with corn the proportion of the nitrogen compounds (protein) in both the seed and the stover was considerably larger in the crops from the plots upon which nitrogen was used in addition to the mixed minerals than it was in the crops from the plots upon which only mineral fertilizers were used. In these experi-

ments also the use of nitrate of soda was more economical than that of sulphate of ammonia.

The number of experiments with oats was not sufficient to warrant deductions as to the quantities or kinds of fertilizer materials supplying nitrogen that may be used on that crop with most economy. In all the experiments in which nitrogen was used the yield was markedly increased. In general, the results are similar to those obtained with mixed grasses and corn. The effect of the nitrogen on the composition of the crop, especially of the seed, was quite marked. This was most noticeable on the plots to which nitrate of soda was applied.

The effect of the nitrogen of the fertilizer in increasing the nitrogen compounds (protein) of the crop was more noticeable in the experiments with distinct species of grasses than in any of the other experiments. The average composition of all the kinds of grasses experimented upon gives the following percentages: in grasses from plots having only mineral fertilizers (phosphoric acid and potash), 7.4 per cent. protein; in those from plots having nitrogen at the rate of 25 pounds per acre, in addition to the minerals, 9.7 per cent. protein; and in those from plots having nitrogen at the rate of 75 pounds per acre, in addition to the minerals, 12.5 per cent. protein. This means that a ton of the crop from the plots upon which nitrogen was used at the rate of 75 pounds per acre would contain (60 per cent.) 120 pounds more protein than would a ton of the crop from the plot upon which minerals only were used, showing that the nitrogen of the fertilizer greatly increased the value of the crop independently of its effect upon the yield.

With soy beans (seed) and cow peas (plants grown for fodder) the results were very different from those with cereals and grasses. The nitrogenous fertilizers had very little effect upon either the yield or the composition of the crops. That is to say, these legumes showed very little increase, either in yield or in the percentages of protein, resulting from the use of nitrogen in the fertilizer. The yield of dry matter in the crops from the nitrogen plots was but very little larger than in the crops from the mineral plots. In protein also the yield was but slightly greater in the crops from the nitrogen plots.

A comparison between relative yields of dry matter and of protein in the grasses and corn on the one hand, and in cow peas and soy beans on the other, is given in the following table, taking the yield from the mineral plots as a basis.

TABLE 24.— *Yields of dry matter and protein in grasses and corn by the use of different quantities of nitrogen, compared with yields in cow peas and soy beans by the use of the same quantities. In these calculations yield with mineral fertilizer only is taken at 100.*

Fertilizers.	GRASSES.		CORN, GRAIN.		COW PEAS, GREEN PLANT.		SOY BEANS, SEEDS.	
	Dry matter.	Protein.	Dry matter.	Protein.	Dry matter.	Protein.	Dry matter.	Protein.
	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
Minerals only,	100	100	100	100	100	100	100	100
Minerals + nitrogen 25 lbs.,	137	127	135	143	104	100	102	105
Minerals + nitrogen 50 lbs.,	177	188	165	181	100	101	115	120
Minerals + nitrogen 75 lbs.,	188	222	168	200	98	100	117	123

PRACTICAL DEDUCTIONS.

One of the clearest deductions that may be made from the results of these experiments is that, in the use of nitrogenous fertilizers, great care should be taken to adapt the fertilizers used to the crop grown.

The true grasses, like timothy and red top, make most of their growth during a short period of time in the early part of the season. For this reason the best results in yield and in feeding value depend upon the amount of nitrogen that is immediately available for the growing plant; and it is important that whatever nitrogen is supplied in fertilizers should be in materials, like sulphate of ammonia or nitrate of soda, in which it is readily available. Corn, however, while it is also a species of grass and a vigorous feeder, grows more slowly, and is able to obtain considerable nitrogen from the organic matter decaying in the soil during the later part of the season. It makes some gain from the nitrogen supplied in nitrogenous fertilizers, but it does not respond so vigorously to their use as do the true grasses.

On the other hand, the legumes, such as clovers, soy beans, and cow peas, make very little gain, either in yield or in feeding value, from the use of nitrogen in the fertilizer. They make considerable increase in yield when the mineral fertilizers are used. A large part of their nitrogen they take from the air.

In brief, the experiments teach that, (1) the grasses are greatly benefited by the proper use of nitrogenous fertilizers;

(2) the legumes are benefited largely and chiefly by the use of mineral fertilizers; (3) the legumes, which take much of their nitrogen from the air and leave a great deal behind in their roots and stubble and otherwise in the soil for the use of plants that come after them, should be grown in rotation with crops of the grass family which feed heavily upon the readily available nitrogen of the soil; (4) all crops need the mineral fertilizers. The cereals and grasses respond also to nitrogen.

DETAILED DATA OF THE EXPERIMENTS.

The following Tables, 25 to 39, give in detail the data from the experiments with the various crops grown upon plots treated with different kinds and amounts of fertilizers. The composition of each crop (except the pure species of grasses) is given in two tables, both based upon the water-free substance in the crop. The first table shows the percentage of protein (nitrogen $\times 6.25$), fat, nitrogen-free extract, and ash contained in the crop at the time of harvesting, as determined by chemical analysis; and the second table shows the yields of nutrients per acre, computed by the use of the percentage composition.

The grasses were generally harvested at, or soon after, the time of blossoming, and in the case of field crops, were sampled immediately after the total weight of the crop was determined. Large samples of 5 to 8 pounds of hay, or about 10 to 35 pounds of grass, were taken for the main sample. These were cut in a feed-cutter into pieces an inch or so in length and well mixed. From the material thus mixed were taken sub-samples of 500 to 1,000 grams of hay, and 1,500 to 4,000 grams of green crop, which were partially dried in a steam dryer. At the laboratory these were ground into a finely pulverized condition preparatory to taking the final sample for analysis.

In much the same way the corn stover was sampled immediately after the corn was husked and the crop weighed. A large sample, about one peck, of the merchantable corn (ears) was selected from each plot, the corn was shelled off at once and the proportion of grain determined. The grain was then partially dried, and later finely ground, and the samples stored in tightly sealed jars until the analyses could be made.

The oats were sampled at the time of threshing and weighing the crop, the sample of straw being taken as in sampling hay. Of the grain a sample of 2 to 6 pounds was taken immediately after the crop was weighed, and, after being partially dried, was finely ground and the samples stored in sealed jars until they could be analyzed.

The cow peas were sampled just after the crop was cut for silage, in much the same way as the grasses, and the seed of the soy beans were sampled in about the same way as oats, just after the crop was thrashed and weighed.

The analyses are published mainly to show the effect of nitrogen in the fertilizer on the proportion of nitrogen compounds (protein) in the crop. The chief point of interest in a study of them is found in a comparison of the protein in the crops from the plots to which only mineral fertilizers were applied, with the protein in the crops from the plots to which nitrogen also was applied at the rate of 25, 50, and 75 pounds per acre. (Compare plots 6, 6a, 6b with plots 7, 8, 9, and 10, 11, 12.)

The data in the tables giving the yields of nutrients per acre were obtained as follows: The weight of the crop at harvest multiplied by the percentage of water-free substance in the crop, as shown by drying the small samples in hydrogen gas at 100° C. (212° F.), gives as a product the total amounts of nutrients, or water-free substance, per acre. The amount of water-free substance multiplied by the percentages of nutrients contained in it, as shown by analysis, gives the yields of these ingredients per acre.

Explanation of Tables 25 and 26. — The analyses given in Table 25 are those of samples of mixed grasses from experiments conducted by the Station during the years 1890, 1891, and 1892. The general plan of the experiment included a series of plots upon all of which, except the "nothing" plots, was applied uniform quantities of phosphoric acid and potash, and, in addition, different quantities of nitrogen. The nitrogen was applied upon three of the plots in nitrate of soda, and upon three others in sulphate of ammonia. The kinds and quantities of the different fertilizers used are given in the second column of the tables. The third column shows the kind of the experiment. In determining the proportions of food constituents, *i. e.*, protein, fat, etc., in the crop, the differences in the proportions of water are left out of account by basing the calculations upon the amount of dry matter or water-free substance in the crop.

It will be noticed that there are more analyses of crops from the plots with nitrate of soda than of crops from the plots with sulphate of ammonia. This is due to the fact that the experiments upon the former plots extended through three years, while those upon the latter extended through only two.

Table 26 gives the total yields of water-free substance and the computed yields of food constituents. The yields of water-free substance per acre were determined from the weights of the crop when harvested and the percentage of water found in the sample when dried. The yields of protein, fat, etc., were calculated by multiplying the weight of the yield of water-free substance per acre, given in this table, by the percentages of protein, fat, etc., found by analysis of the samples from the corresponding plots as given in Table 25.

In all the experiments the results from plots with like kinds and quantities of fertilizers are averaged, as shown by figures in bold face type. These averages are the values which are given in the summary Tables 9 and 10, on pages 130 and 132 in the discussion of results.

TABLE 25.—*Effects of nitrogenous fertilizers upon hay of mixed grasses.*
 [The details of the analyses may be found in the Reports of the Station for the years in which the several experiments were made or for the succeeding year.]

Year.	Plot No. and kind and amount of fertilizer per acre.	Kind of experiment.	Laboratory No.	PERCENTAGE COMPOSITION OF HAY CALCULATED ON WATER-FREE SUBSTANCE.				
				Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
				Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.
	<i>Nothing.</i>							
1890	Plot o,	Spe. nitrogen	804	7.25	3.72	52.56	31.45	5.02
1890	Duplicate of last,	"	805	7.06	3.68	53.27	31.16	4.83
1890	oo,	"	806	7.13	3.61	52.75	31.59	4.92
1890	Duplicate of last,	"	807	7.50	4.28	51.99	31.16	5.07
1890	o, Duplicate of above,	"	824	7.63	3.50	52.75	31.07	5.05
1890	oo, Duplicate of above,	"	825	7.56	3.76	52.27	31.20	5.21
1891	o,	"	990	6.44	3.38	54.58	31.06	4.54
1891	oo,	"	991	7.31	3.94	52.01	31.72	5.02
1892	o,	"	1,054	7.69	3.17	51.43	32.57	5.14
	Average, . . . . .		...	7.29	3.67	52.62	31.44	4.98
	<i>Dis. boneblack, 320 lbs.</i>							
	<i>Mur. of potash, 160 lbs.</i>							
	<i>Nitrogen, —</i>							
1890	Plot 6a,	Spe. nitrogen	808	8.00	3.07	50.12	32.95	5.86
1890	Duplicate of last,	"	809	7.94	2.98	50.12	33.24	5.72
1890	6b,	"	810	7.94	3.31	51.07	32.01	5.67
1890	Duplicate of last,	"	811	8.31	3.52	50.23	32.10	5.84
1890	6a, Duplicate of above,	"	826	8.75	3.57	49.65	32.16	5.87
1890	6b, Duplicate of above,	"	827	8.44	3.94	49.46	32.16	6.00
1891	6a,	"	992	6.63	3.45	53.63	31.10	5.19
1891	6b,	"	993	7.31	4.03	51.13	31.84	5.69
1892	6a (total crop),	"	*1,055	10.94	3.19	47.25	32.00	6.62
1892	6a (grasses only),	"	1,059	7.19	3.09	52.04	33.35	4.33
	Average, . . . . .		....	7.83	3.44	50.84	32.32	5.57
	<i>Dis. Boneblack, 320 lbs.</i>							
	<i>Mur. of potash, 160 lbs.</i>							
	<i>Nitr. of soda, 160 lbs. (nitrogen, 25 lbs.)</i>							
1890	Plot 7,	Spe. nitrogen	812	8.38	3.77	48.38	33.87	5.60
1890	Duplicate of last,	"	813	8.56	3.49	48.64	33.64	5.67
1890	Duplicate of last,	"	828	8.19	3.85	49.48	33.11	5.37
1891	7,	"	994	6.94	3.66	52.28	32.01	5.11
1892	7,	"	1,056	7.69	3.34	49.29	34.16	5.52
	Average, . . . . .		....	7.95	3.62	49.62	33.36	5.45
	<i>Dis. boneblack, 320 lbs.</i>							
	<i>Mur. of potash, 160 lbs.</i>							
	<i>Nitr. of soda, 320 lbs. (nitrogen, 50 lbs.)</i>							
1890	Plot 8,	Spe. nitrogen	814	8.19	3.56	48.50	34.58	5.17
1890	Duplicate of last,	"	815	8.19	3.27	48.58	34.93	5.03
1890	Duplicate of last,	"	829	7.88	3.65	49.00	34.32	5.15
1891	8,	"	995	8.75	4.08	49.15	32.69	5.33
1892	8,	"	1,057	9.31	3.60	47.55	33.93	5.52
	Average, . . . . .		....	8.46	3.65	48.56	34.09	5.24

* Omitted from average.

TABLE 25.—CONTINUED.

Year.	Plot No. and kind and amount of fertilizer per acre.	Kind of experiment.	Laboratory No.	PERCENTAGE COMPOSITION OF HAY CALCULATED ON WATER FREE SUBSTANCE.				
				Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
				Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.	Pr. ct.
	<i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Nitr. of soda, 480 lbs. (nitrogen, 75 lbs.)</i>							
1890	Plot 9,	Spe. nitrogen	816	9.00	3.23	47.99	34.70	5.08
1890	Duplicate of last,	"	817	9.31	3.13	47.83	34.48	5.25
1890	Duplicate of last,	"	830	9.25	4.16	46.98	34.48	5.13
1891	9,	"	996	9.00	4.29	49.98	31.40	5.33
1892	9,	"	1,058	10.56	3.57	47.00	33.14	5.73
	Average,		....	9.42	3.68	47.96	33.64	5.30
	<i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Sul. of amm., 120 lbs. (nitrogen, 25 lbs.)</i>							
1890	Plot 10,	Spe. nitrogen	818	7.50	3.41	48.99	34.82	5.28
1890	Duplicate of last,	"	819	7.50	3.28	50.12	33.79	5.31
1890	Duplicate of last,	"	831	7.63	3.85	49.05	34.00	5.47
1891	10,	"	997	7.38	3.86	51.61	31.87	5.28
	Average,		....	7.50	3.60	49.94	33.62	5.34
	<i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Sul. of Amm., 240 lbs. (nitrogen, 50 lbs.)</i>							
1890	Plot 11,	Spe. nitrogen	820	8.31	5.90	46.49	34.07	5.23
1890	Duplicate of last,	"	821	8.20	3.53	48.69	34.57	5.01
1890	Duplicate of last,	"	832	8.56	3.64	49.14	33.31	5.75
1891	11,	"	998	8.75	4.08	49.73	31.66	5.78
	Average,		....	8.46	4.29	48.51	33.40	5.34
	<i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Sul. of Amm., 360 lbs. (nitrogen, 75 lbs.)</i>							
1890	Plot 12,	Spe. nitrogen	822	9.13	3.33	48.21	34.23	5.10
1890	Duplicate of last,	"	823	9.50	3.44	48.82	33.07	5.17
1890	Duplicate of last,	"	833	8.88	4.20	48.14	33.75	5.03
1891	12,	"	999	9.04	4.30	49.55	30.61	5.60
	Average,		....	9.36	3.82	48.68	32.91	5.23

TABLE 26.—*Effects of nitrogenous fertilizers upon hay of mixed grasses.*

[The details of the experiments may be found in the Reports of the Station for the years in which the several experiments were made or for the year following.]

Year.	Plot No. and kind and amount of fertilizer per acre.	Kind of experiment.	YIELDS OF DRY MATTER AND NUTRIENTS IN HAY PER ACRE.					
			Water free substance.	Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
			lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
	<i>Nothing.</i>							
1890	Plot o,	Spe. nitrogen	1,707	125	62	902	533	85
1890	oo,	"	2,505	185	97	1,311	785	127
1891	o,	"	1,531	99	52	836	475	69
1891	oo,	"	1,483	108	58	772	470	75
1892	o,	"	1,147	88	36	590	374	59
	Average,		1,675	121	61	882	527	83
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Nitrogen, —</i>							
1890	Plot 6a,	Spe. nitrogen	2,989	246	96	1,493	980	174
1890	6b,	"	3,204	264	115	1,610	1,028	187
1891	6a,	"	1,956	130	67	1,049	608	102
1891	6b,	"	1,908	139	77	976	607	109
1892	6a,	"	1,782	195	57	842	570	118
	Average,		2,368	195	82	1,194	759	138
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Nitrogen (different forms), 25 lbs.</i>							
1890	Plots 7, 10,	Spe. nitrogen	4,190	334	151	2,058	1,419	228
1891	7, 10,	"	2,813	201	106	1,462	898	146
1892	7,	"	2,716	209	91	1,338	928	150
	Average,		3,240	248	116	1,619	1,082	175
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Nitrogen (different forms), 50 lbs.</i>							
1890	Plots 8, 11,	Spe. nitrogen	5,151	424	202	2,492	1,767	266
1891	8, 11,	"	3,735	327	152	1,846	1,203	207
1892	8,	"	3,720	346	137	1,769	1,263	205
	Average,		4,202	366	164	2,036	1,411	226
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Nitrogen (different forms), 75 lbs.</i>							
1890	Plots 9, 12,	Spe. nitrogen	5,370	493	193	2,576	1,832	276
1891	9, 12,	"	3,777	357	162	1,880	1,176	207
1892	9,	"	4,227	446	151	1,987	1,401	242
	Average,		4,458	432	169	2,148	1,470	242

Explanation of Tables 27, 28, 29, 30. — Tables 27 and 28 show the analyses of samples of corn (grain) and stover respectively, taken in experiments extending over a period of nine years, although most of the experiments on a single field were not repeated more than once or twice. Two kinds of experiments were made; (1) soil tests, conducted primarily to study the deficiencies of soils in regard to the chief fertilizer ingredients; and (2) special nitrogen experiments conducted for the purpose of studying the effects of the nitrogenous fertilizers on the yield and the composition of the crop. In some cases the soil tests were a part of the special nitrogen experiments. In many of the soil tests samples for analysis have been taken, and the results averaged with those of the special nitrogen tests, from plots upon which the fertilizers applied were alike in kind and amount. (See plots A and 1, B and 2, G and 7.) The percentages of food constituents in the corn and in the stover are calculated upon the basis of water-free substance in the crop when it was harvested. The averages, given in bold face type, are the values used in the summary Tables 12 and 13, pages 136 and 138 in the discussion of results.

Tables 29 and 30 give the total yields of water-free substance and of the various food constituents in corn and stover from the same series of experiments. The amounts of water-free substance were determined by the weight of the corn and stover, and the percentage of water they contained, at the time when they were harvested. The amounts of food constituents were estimated from the water-free substance and composition shown by analyses. The averages given in bold face type in these tables are found in the summary Table 14, page 140 in the discussion.

TABLE 27.—*Effects of nitrogenous fertilizers upon corn (grain, flint varieties).*

[The details of the analyses may be found in the Reports of the Station for the years in which the several experiments were made or for the succeeding year.]

Year.	Plot no. and kind and amount of fertilizer per acre.	Kind of experiment.	Laboratory No.	PERCENTAGE COMPOSITION OF CORN CALCULATED ON WATER-FREE SUBSTANCE.				
				Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
				Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
<i>Nothing.</i>								
1888	Plots o and oo, . . .	Soil test	603	11.13	5.13	80.48	1.55	1.71
1888	o and oo, . . .	Spe. nitrogen	629	13.06	5.65	78.34	1.42	1.53
1888	o and oo, . . .	"	639	11.56	5.63	79.48	1.55	1.78
1888	o and oo, . . .	"	659	12.06	5.32	79.38	1.63	1.61
1888	o and oo, . . .	"	669	11.56	5.25	79.86	1.74	1.59
1889	o and oo, . . .	"	695	12.50	5.30	78.44	1.88	1.88
1889	o and oo, . . .	"	727	11.44	6.01	78.25	2.25	2.05
1889	o and oo, . . .	Soil test	753	11.06	5.27	79.80	1.98	1.89
1890	o, . . .	"	873	10.56	5.50	80.89	1.52	1.53
1890	Duplicate of last, oo, . . .	"	875	10.31	5.13	81.39	1.54	1.63
1890	oo, . . .	"	877	10.75	5.22	80.94	1.46	1.63
1890	Duplicate of last, o, . . .	"	879	10.19	4.91	81.85	1.52	1.53
1890	o, . . .	"	913	12.38	4.84	78.72	2.14	1.92
1890	oo, . . .	"	917	11.13	4.84	80.29	1.96	1.78
1891	o, . . .	Spe. nitrogen	1,030	11.00	5.69	80.32	1.32	1.67
1895	o, . . .	"	1,547	10.37	5.85	80.37	1.65	1.76
1895	oo, . . .	"	1,548	10.91	5.26	80.81	1.36	1.66
1895	o, . . .	"	1,567	10.42	6.43	79.59	1.69	1.89
1895	oo, . . .	"	1,568	10.56	5.44	80.95	1.44	1.61
1896	o, . . .	"	1,756	9.90	5.81	80.60	2.08	1.61
1896	oo, . . .	"	1,757	10.22	5.84	80.20	1.92	1.82
1896	o, . . .	"	1,766	11.14	5.46	80.14	1.47	1.79
1896	oo, . . .	"	1,767	11.21	5.20	80.27	1.61	1.71
	Average, . . .		....	11.15	5.43	80.06	1.64	1.72
<i>Nitrate of soda, 160 lbs.</i>								
1888	Plot A, . . .	Soil test	605	10.94	5.12	80.85	1.50	1.59
1888	1, . . .	Spe. nitrogen	627	13.25	5.34	78.31	1.50	1.60
1888	1, . . .	"	641	11.63	6.00	78.97	1.66	1.74
1888	1, . . .	"	671	12.25	5.24	79.11	1.74	1.66
1889	1, . . .	"	697	12.75	5.11	77.95	2.27	1.92
1889	A, . . .	Soil test	755	11.94	5.81	78.09	2.11	2.05
1890	A, . . .	"	881	12.06	5.09	80.02	1.38	1.45
1890	Duplicate of last, A, . . .	"	883	10.63	5.04	81.35	1.48	1.50
1890	A, . . .	"	921	11.81	5.06	79.91	1.58	1.64
	Average, . . .		....	11.92	5.31	79.40	1.69	1.68
<i>Dissolved boneblack, 320 lbs.</i>								
1888	Plot B, . . .	Soil test	607	11.38	5.33	80.27	1.41	1.61
1888	2, . . .	Spe. nitrogen	625	13.38	5.60	78.00	1.39	1.63
1888	2, . . .	"	643	11.06	5.58	79.96	1.55	1.85
1888	2, . . .	"	673	11.63	5.55	79.67	1.72	1.63
1889	2, . . .	"	699	13.25	5.30	77.38	2.06	2.01
1889	2, . . .	"	729	10.44	5.18	80.49	2.05	1.84
1889	B, . . .	Soil test	757	11.06	5.23	79.85	2.08	1.78
1890	B, . . .	"	885	10.31	5.28	81.28	1.46	1.67
1890	Duplicate of last, B, . . .	"	887	10.38	5.08	81.59	1.42	1.53
1890	B, . . .	"	925	10.94	4.73	80.78	1.86	1.69
	Average, . . .		....	11.38	5.27	79.93	1.70	1.72

TABLE 27.—CONTINUED.

Year.	Plot No. and kind and amount of fertilizer per acre.	Kind of experiment.	Laboratory No.	PERCENTAGE COMPOSITION OF CORN CALCULATED ON WATER-FREE SUBSTANCE.				
				Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
	<i>Muriate of potash, 160 lbs.</i>			Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
1888	Plot C,	Soil test	609	9.88	5.25	81.66	1.55	1.66
1888	3,	Spe. nitrogen	623	13.06	5.23	78.34	1.66	1.71
1888	3,	"	645	10.25	5.57	80.95	1.49	1.74
1888	3,	"	675	10.88	5.08	80.86	1.63	1.55
1889	3,	"	701	10.19	5.65	80.43	1.84	1.89
1889	3,	"	731	10.38	4.93	80.90	2.06	1.73
1889	C,	Soil test	759	11.06	5.17	80.07	1.88	1.82
1890	C,	"	889	11.19	5.19	80.73	1.39	1.50
1890	Duplicate of last,	"	891	9.56	5.00	82.52	1.40	1.52
1890	C,	"	929	8.44	5.01	83.23	1.89	1.43
	Average,		....	10.49	5.21	80.97	1.68	1.65
	<i>Dis. boneblack, 320 lbs.</i>							
	<i>Nitrate of soda, 160 lbs.</i>							
1888	Plot D,	Soil test	611	11.94	5.78	79.05	1.52	1.71
1888	4,	Spe. nitrogen	621	13.38	6.34	77.09	1.47	1.72
1888	4,	"	647	12.44	5.60	78.45	1.69	1.82
1888	4,	"	677	12.00	5.36	79.23	1.57	1.84
1889	4,	"	703	12.44	6.87	77.12	1.58	1.99
1889	D,	Soil test	761	11.44	4.99	79.83	1.91	1.83
1890	D,	"	893	11.31	5.33	80.40	1.44	1.52
1890	Duplicate of last,	"	895	11.56	5.17	80.26	1.47	1.54
1890	D,	"	933	11.31	5.05	80.21	1.81	1.62
	Average,		....	11.98	5.61	79.07	1.61	1.73
	<i>Muriate of potash, 160 lbs.</i>							
	<i>Nitrate of soda, 160 lbs.</i>							
1888	Plot E,	Soil test	613	12.94	5.43	78.43	1.52	1.68
1888	5,	Spe. nitrogen	619	13.13	5.64	78.19	1.54	1.50
1888	5,	"	649	11.63	5.60	79.38	1.65	1.74
1888	5,	"	679	10.50	5.54	81.01	1.35	1.60
1889	5,	"	705	10.44	6.26	79.33	1.86	2.11
1889	E,	Soil test	763	12.00	5.19	78.69	2.00	2.12
1890	E,	"	897	10.19	5.04	81.74	1.37	1.66
1890	Duplicate of last,	"	899	10.19	5.06	81.84	1.38	1.53
1890	E,	"	937	9.00	5.11	82.80	1.65	1.44
	Average,		....	11.11	5.43	80.16	1.59	1.71
	<i>Dis. boneblack, 320 lbs.</i>							
	<i>Muriate of potash, 160 lbs.</i>							
	<i>Nitrogen, —</i>							
1888	Plot F,	Soil test	615	10.75	5.35	80.62	1.63	1.65
1888	6, 6a, 6b,	Spe. nitrogen	631	12.50	5.55	78.88	1.53	1.54
1888	6, 6a, 6b, 6c,	"	651	9.88	5.64	81.16	1.56	1.76
1888	6, 6a, 6b, 6c,	"	661	11.44	5.57	79.72	1.62	1.55
1888	6, 6a, 6b, 6c,	"	681	10.94	5.21	80.61	1.62	1.62
1889	6, 6a, 6b, 6c,	"	725	9.69	6.27	80.52	1.69	1.83
1889	6, 6a,	"	733	10.88	6.78	77.95	2.22	2.17
1889	F,	Soil test	765	11.06	4.73	80.64	1.77	1.80
1890	F,	"	901	10.38	5.29	81.39	1.33	1.61
1890	Duplicate of last,	"	903	10.06	5.41	81.52	1.39	1.62

TABLE 27.—CONTINUED.

Year.	Plot No. and kind and amount of fertilizer per acre.	Kind of experiment.	Laboratory No.	PERCENTAGE COMPOSITION OF CORN CALCULATED ON WATER-FREE SUBSTANCE.				
				Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
				Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
1890	<i>Dis. boneblack, etc.</i>							
	Plot F,	Soil test	941	8.25	5.26	83.24	1.72	1.53
1891	6,	Spe. nitrogen	1,031	10.88	5.85	80.19	1.44	1.64
1895	6a,	"	1,549	8.97	6.49	80.92	1.88	1.74
1895	6b,	"	1,550	8.68	5.88	81.57	2.20	1.67
1895	6a,	"	1,569	9.81	6.57	80.35	1.46	1.81
1895	6b,	"	1,570	10.42	6.54	79.60	1.55	1.89
1896	6a,	"	1,758	9.31	6.21	80.66	2.03	1.79
1896	6b,	"	1,759	9.38	5.88	81.01	2.03	1.70
1896	6a,	"	1,768	9.58	5.35	82.00	1.33	1.74
1896	6b,	"	1,769	9.82	5.34	82.03	1.81	1.60
	Average,		....	10.13	5.76	80.73	1.66	1.72
	<i>Dis. boneblack, 320 lbs.</i>							
	<i>Muriate of potash, 160 lbs.</i>							
	<i>Nitr. of soda, 160 lbs. (nitrogen, 25 lbs.)</i>							
1888	Plot G,	Soil test	617	11.69	5.26	79.70	1.59	1.76
1888	7, 10, 13,* . . .	Spe. nitrogen	633	12.44	5.70	78.84	1.44	1.58
1888	7, 10, 13,* . . .	"	653	10.19	5.42	81.29	1.47	1.63
1888	7, 10, 13,* . . .	"	663	12.69	5.45	78.44	1.81	1.61
1888	7, 10, 13,* . . .	"	683	12.69	6.15	77.90	1.49	1.77
1889	7,	"	707	10.50	7.22	78.23	1.99	2.06
1889	7,	"	735	10.50	5.78	79.90	2.05	1.77
1889	G,	Soil test	767	10.94	5.04	80.51	1.84	1.57
1890	G,	"	905	11.52	5.32	80.25	1.33	1.60
1890	Duplicate of last,	"	907	11.25	5.31	80.46	1.44	1.54
1890	G,	"	945	9.06	5.39	82.56	1.55	1.44
1890	Ga,	"	949	8.69	5.04	83.28	1.48	1.51
1891	7,	Spe. nitrogen	1,032	11.00	5.92	80.23	1.19	1.66
1895	7,	"	1,551	10.26	6.03	80.51	1.42	1.78
1895	7,	"	1,571	10.62	7.67	77.89	1.67	2.15
1896	7,	"	1,760	9.34	5.60	82.16	1.36	1.54
1896	7,	"	1,770	10.17	5.89	80.58	1.35	2.01
	Average,		....	10.80	5.77	80.16	1.56	1.71
	<i>Dis. boneblack, 320 lbs.</i>							
	<i>Muriate of potash, 160 lbs.</i>							
	<i>Nitr. of soda, 320 lbs. (nitrogen 50 lbs.)</i>							
1888	Plots 8, 11, 14,* . .	Spe. nitrogen	635	13.25	5.72	77.97	1.46	1.60
1888	8, 11, 14,* . . .	"	655	10.50	5.36	80.94	1.59	1.61
1888	8, 11, 14,* . . .	"	665	12.19	5.66	78.90	1.67	1.58
1888	8, 11, 14,* . . .	"	685	11.75	5.65	79.39	1.50	1.71
1889	8,	"	709	11.25	7.12	77.60	1.96	2.07
1889	8,	"	737	11.00	5.77	79.35	2.11	1.77
1895	8,	"	1,552	10.92	6.45	79.34	1.49	1.80
1895	8,	"	1,572	11.87	6.94	77.77	1.53	1.89
1896	8,	"	1,761	10.76	5.85	80.31	1.39	1.69
1896	8,	"	1,771	11.40	6.73	78.23	1.74	1.90
	Average,		....	11.50	6.12	78.98	1.64	1.76

* Combined samples (three forms of nitrogen).

TABLE 27.—CONTINUED.

Year.	Plot No. and kind and amount of fertilizer per acre.	Kind of experiment.	Laboratory No.	PERCENTAGE COMPOSITION OF CORN CALCULATED ON WATER-FREE SUBSTANCE.				
				Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
	<i>Dis. boneblack, 320 lbs.</i> <i>Muriate of potash, 160 lbs.</i> <i>Nitr. of soda, 480 lbs. (nitrogen, 75 lbs.)</i>			Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
1888	Plots 9, 12, 15,*	Spe. nitrogen	637	14.38	5.67	76.89	1.37	1.69
1888	9, 12, 15,*	"	657	11.75	5.63	79.40	1.52	1.70
1888	9, 12, 15,*	"	667	13.19	5.59	77.93	1.69	1.60
1888	9, 12, 15,*	"	687	12.00	5.10	79.74	1.53	1.63
1889	9,	"	711	9.88	7.03	79.14	1.83	2.12
1889	9,	"	739	11.19	6.14	78.15	2.24	2.28
1891	9,	"	1,033	11.88	6.25	78.77	1.41	1.69
1895	9,	"	1,553	11.93	5.80	78.97	1.59	1.71
1895	9,	"	1,573	12.48	7.05	76.83	1.56	2.08
1896	9,	"	1,762	11.68	6.28	78.81	1.46	1.77
1896	9,	"	1,772	12.46	5.67	78.46	1.60	1.81
	Average,		....	12.07	6.02	78.46	1.62	1.83
	<i>Dis. boneblack, 320 lbs.</i> <i>Muriate of potash, 160 lbs.</i> <i>Sul. of ammo., 120 lbs. (nitrogen, 25 lbs.)</i>							
1889	Plot 10,	Spe. nitrogen	713	9.00	6.48	80.94	1.74	1.84
1889	10,	"	743	10.31	5.80	79.56	2.41	1.92
1895	10,	"	1,554	10.27	6.69	79.86	1.53	1.65
1895	10,	"	1,574	11.00	6.91	78.61	1.53	1.95
1896	10,	"	1,763	10.20	6.79	79.56	1.60	1.85
1896	10,	"	1,773	10.91	5.56	80.62	1.26	1.65
	Average,		....	10.28	6.37	79.86	1.68	1.81
	<i>Dis. boneblack, 320 lbs.</i> <i>Muriate of potash, 160 lbs.</i> <i>Sul. of ammo., 240 lbs. (nitrogen, 50 lbs.)</i>							
1889	Plot 11,	Spe. nitrogen	715	8.94	6.78	80.85	1.64	1.79
1889	11,	"	743	12.06	5.92	77.82	2.27	1.93
1895	11,	"	1,555	10.37	6.12	80.40	1.50	1.61
1895	11,	"	1,575	11.42	7.43	77.57	1.54	2.04
1896	11,	"	1,764	9.87	6.98	79.64	1.58	1.93
1896	11,	"	1,774	10.96	6.55	78.94	1.54	2.01
	Average,		....	10.60	6.63	79.20	1.68	1.89
	<i>Dis. boneblack, 320 lbs.</i> <i>Muriate of potash, 160 lbs.</i> <i>Sul. of ammo., 360 lbs. (nitrogen, 75 lbs.)</i>							
1889	Plot 12,	Spe. nitrogen	717	11.13	6.18	78.96	1.85	1.88
1889	12,	"	745	11.50	6.38	78.05	2.07	2.00
1895	12,	"	1,556	12.11	6.87	77.60	1.57	1.85
1895	12,	"	1,576	12.19	7.05	77.25	1.49	2.02
1896	12,	"	1,765	11.13	6.16	79.62	1.31	1.78
1896	12,	"	1,775	12.04	6.36	78.34	1.30	1.96
	Average,		...	11.68	6.50	78.30	1.60	1.92

* Combined samples (three forms of nitrogen).

TABLE 27.—CONTINUED.

Year.	Plot No. and kind and amount of fertilizer per acre.	Kind of experiment.	Laboratory No.	PERCENTAGE COMPOSITION OF CORN CALCULATED ON WATER-FREE SUBSTANCE.				
				Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
	<i>Dis. boneblack, 320 lbs. Muriate of potash, 160 lbs. Dried blood, 200 lbs. (nitrogen, 25 lbs.)</i>			Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
1889	Plot 13,	Spe. nitrogen	719	9.81	6.94	79.39	1.88	1.98
1889	13,	"	747	10.06	5.71	80.38	2.00	1.85
	Average,		....	9.93	6.33	79.88	1.94	1.92
	<i>Dis. boneblack, 320 lbs. Muriate of potash, 160 lbs. Dried blood, 400 lbs. (nitrogen, 50 lbs.)</i>							
1889	Plot 14,	Spe. nitrogen	721	9.06	5.93	81.37	1.84	1.80
1889	14,	"	749	6.63	4.99	81.94	1.86	1.58
	Average,		....	9.34	5.46	81.66	1.85	1.69
	<i>Dis. boneblack, 320 lbs. Muriate of potash, 160 lbs. Dried blood, 600 lbs. (nitrogen, 75 lbs.)</i>							
1889	Plot 15,	Spe. nitrogen	723	9.19	6.09	80.98	1.89	1.85
1889	15,	"	751	10.31	5.65	80.15	2.08	1.81
	Average,		....	9.75	5.87	80.56	1.99	1.83

TABLE 28.—*Effects of nitrogenous fertilizers upon corn stover (flint varieties).*

[The details of the analyses may be found in the Reports of the Station for the years in which the several experiments were made or for the succeeding year.]

Year.	Plot No. and kind and amount of fertilizer per acre.	Kind of experiment.	Laboratory No.	PERCENTAGE COMPOSITION OF CORN STOVER CALCULATED ON WATER-FREE SUBSTANCE.				
				Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
				Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
1888	<i>Nothing.</i>							
1888	Plots o and oo, . . .	Soil test	604	4.69	1.64	50.66	37.25	5.76
1888	o and oo, . . .	Spe. nitrogen	630	10.06	2.57	48.33	31.09	7.95
1888	o and oo, . . .	"	640	8.25	2.44	52.37	30.74	6.20
1888	o and oo, . . .	"	660	7.13	1.59	48.25	35.87	7.16
1888	o and oo, . . .	"	670	8.94	1.89	50.67	31.37	7.13
1889	o and oo, . . .	"	694	7.94	1.77	48.49	36.34	5.46
1889	o and oo, . . .	"	726	6.44	2.07	51.85	33.91	5.73
1889	o and oo, . . .	Soil test	752	7.25	2.09	52.35	32.72	5.59
1890	o, . . .	"	872	4.06	1.52	50.06	39.16	5.20
1890	Duplicate of last, oo, . . .	"	874	4.63	1.66	50.49	37.43	5.79
1890	Duplicate of last, oo, . . .	"	876	5.75	1.66	50.33	37.49	4.77
1890	Duplicate of last, o, . . .	"	878	5.44	1.78	49.99	37.20	8.59
1890	oo, . . .	"	912	10.00	1.83	52.19	31.21	4.77
1890	oo, . . .	"	916	8.88	1.66	52.05	32.42	4.99
1891	o, . . .	Spe. nitrogen	1,017	7.00	2.59	51.90	30.90	7.61
1895	o, . . .	"	1,537	5.82	1.54	51.92	35.43	5.29
1895	oo, . . .	"	1,538	5.91	1.75	52.08	36.23	4.03
1895	o, . . .	"	1,557	5.60	1.75	54.98	31.82	5.85
1895	oo, . . .	"	1,558	7.10	1.77	51.68	31.74	7.71
1896	o, . . .	"	1,736	7.75	1.24	52.10	31.27	7.64
1896	oo, . . .	"	1,737	6.70	1.98	46.23	37.72	7.37
1896	o, . . .	"	1,746	7.33	1.79	48.63	34.59	7.66
1896	oo, . . .	"	1,747	6.37	1.66	49.87	34.90	7.20
	Average,			6.91	1.84	50.76	34.30	6.19
1888	<i>Nitrate of soda, 160 lbs.</i>							
1888	Plot A, . . .	Soil test	606	5.63	2.12	50.27	36.66	5.32
1888	1, . . .	Spe. nitrogen	628	9.75	2.37	49.20	31.75	6.93
1888	1, . . .	"	642	7.06	1.76	52.79	32.76	5.63
1888	1, . . .	"	672	8.81	1.97	49.85	33.90	5.47
1889	1, . . .	"	696	9.63	1.69	54.59	29.69	4.40
1889	A, . . .	Soil test	754	8.56	1.86	51.02	32.97	5.59
1890	A, . . .	"	880	5.06	2.08	49.77	38.26	4.83
1890	Duplicate of last, A, . . .	"	882	5.56	2.16	49.50	37.58	5.20
1890	A, . . .	"	920	9.63	1.62	51.59	32.14	5.02
	Average,			7.74	1.96	50.95	33.97	5.38
1888	<i>Dissolved boneblack, 320 lbs.</i>							
1888	Plot B, . . .	Soil test	608	4.50	1.81	51.21	36.70	5.78
1888	2, . . .	Spe. nitrogen	626	9.44	2.27	47.91	32.20	8.18
1888	2, . . .	"	644	6.94	2.31	52.43	31.83	6.59
1888	2, . . .	"	674	8.94	2.27	49.96	32.35	6.48
1889	2, . . .	"	698	9.38	1.68	52.97	30.73	5.24
1889	2, . . .	"	728	4.69	2.03	53.10	34.81	5.37
1889	B, . . .	Soil test	756	7.69	2.03	51.76	33.00	5.52
1890	B, . . .	"	884	4.69	2.57	49.75	37.29	5.70
1890	Duplicate of last, B, . . .	"	886	4.06	1.88	51.06	38.10	4.90
1890	B, . . .	"	924	10.06	1.55	50.47	32.42	5.50
	Average,			7.04	2.03	51.06	33.94	5.93

TABLE 28. — CONTINUED.

Year.	Plot No. and kind and amount of fertilizer per acre.	Kind of experiment.	Laboratory No.	PERCENTAGE COMPOSITION OF CORN STOVER CALCULATED ON WATER-FREE SUBSTANCE.				
				Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
				Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
1888	<i>Muriate of potash, 160 lbs.</i>							
	Plot C,	Soil test	610	4.31	2.05	50.97	36.77	5.90
1888	3,	Spe. nitrogen	624	10.19	2.19	49.53	31.20	6.89
1888	3,	"	646	7.13	2.16	50.62	32.46	7.63
1888	3,	"	676	7.81	2.06	49.96	32.32	7.85
1889	3,	"	700	5.63	1.94	56.99	29.97	5.47
1889	3,	"	730	4.44	1.82	55.71	32.58	5.45
1889	C,	Soil test	758	7.06	2.02	51.78	33.22	5.92
1890	C,	"	888	4.75	2.33	48.98	37.54	6.40
1890	Duplicate of last,	"	890	4.13	1.78	49.62	38.63	5.84
1890	C,	"	928	8.56	3.12	50.04	32.88	5.40
	Average,			6.40	2.15	51.42	33.76	6.27
	<i>Dissolved boneblack, 320 lbs.</i>							
	<i>Nitrate of soda, 160 lbs.</i>							
1888	Plot D,	Soil test	612	5.44	1.90	51.40	36.12	5.14
1888	4,	Spe. nitrogen	622	8.88	2.07	49.89	32.76	6.40
1888	4,	"	648	8.94	1.75	51.42	32.12	5.77
1888	4,	"	678	8.31	1.92	49.90	33.27	6.60
1889	4,	"	702	9.31	1.71	53.57	30.25	5.16
1889	D,	Soil test	760	7.88	2.10	51.32	32.98	5.72
1889	D,	"	802	4.88	1.93	51.19	36.75	5.25
1890	Duplicate of last,	"	894	4.94	2.09	51.46	36.84	4.67
1890	D,	"	932	9.06	1.53	50.78	33.91	4.72
	Average,			7.52	1.89	51.21	33.89	5.49
	<i>Muriate of potash, 160 lbs.</i>							
	<i>Nitrate of soda, 160 lbs.</i>							
1888	Plot E,	Soil test	614	5.50	1.79	49.63	37.05	6.03
1888	5,	Spe. nitrogen	620	9.31	2.16	47.68	33.15	7.70
1888	5,	"	650	7.69	2.13	51.11	32.84	6.23
1888	5,	"	680	8.75	2.10	49.88	31.86	7.41
1889	5,	"	704	5.50	1.73	52.51	34.28	5.98
1889	E,	Soil test	762	8.31	1.86	51.47	32.83	5.53
1890	E,	"	896	4.75	2.20	49.49	37.72	5.84
1890	Duplicate of last,	"	898	4.88	1.89	49.78	37.51	5.94
1890	E,	"	936	5.75	2.09	52.04	34.80	5.32
	Average,			6.72	1.99	50.40	34.67	6.22
	<i>Dissolved boneblack, 320 lbs.</i>							
	<i>Muriate of potash, 160 lbs.</i>							
	<i>Nitrogen,—</i>							
1888	Plot F,	Soil test	616	4.38	1.75	51.16	36.55	6.16
1888	6, 6a, 6b,	Spe. nitrogen	632	8.75	2.03	47.65	33.48	8.09
1888	6, 6a, 6b, 6c,	"	652	6.13	2.61	51.55	32.48	7.23
1888	6, 6a, 6b, 6c,	"	662	7.06	1.61	48.56	35.22	7.55
1888	6, 6a, 6b, 6c,	"	682	6.06	2.09	51.36	33.92	6.57
1889	6, 6a, 6b, 6c,	"	724	4.63	2.19	56.66	31.13	5.39
1889	6, 6a,	"	732	5.06	1.73	54.95	31.83	6.43
1889	F,	Soil test	764	6.56	2.52	52.17	32.29	6.46
1890	F,	"	900	4.19	2.02	50.13	37.38	6.28
1890	Duplicate of last,	"	902	3.88	1.82	50.61	37.82	5.87

TABLE 28. — CONTINUED.

Year.	Plot No. and kind and amount of fertilizers per acre.	Kind of experiment.	Laboratory No.	PERCENTAGE COMPOSITION OF CORN STOVER CALCULATED ON WATER FREE SUBSTANCE.				
				Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
				Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
1890	<i>Dissolved boneblack, etc.</i>							
	Plot F,	Soil test	940	4.25	2.67	55.20	32.78	5.10
1891	6,	Spe. nitrogen	1,018	5.56	2.33	51.71	31.64	8.76
1895	6a,	"	1,539	4.72	2.24	53.73	33.65	5.66
1895	6b,	"	1,540	4.62	2.08	50.82	37.05	5.43
1895	6a,	"	1,559	3.40	1.68	55.05	33.57	6.30
1895	6b,	"	1,560	3.90	2.42	54.23	32.63	6.82
1896	6a,	"	1,738	5.37	2.11	49.12	36.13	7.27
1896	6b,	"	1,739	5.07	2.27	50.11	35.24	7.31
1896	6a,	"	1,748	4.77	2.11	51.24	33.43	8.45
1896	6b,	"	1,749	4.52	1.75	49.46	36.03	8.24
	Average,			5.15	2.10	51.77	34.21	6.77
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Nitrate of soda, 160 lbs. (nitrogen, 25 lbs.)</i>							
1888	Plot G,	Soil test	618	4.81	1.55	51.21	36.31	6.12
1888	7, 10, 13,*	Spe. nitrogen	634	8.06	2.18	49.12	33.10	7.54
1888	7, 10, 13,*	"	654	6.19	2.02	51.50	32.82	7.47
1888	7, 10, 13,*	"	664	8.19	1.84	46.73	35.66	7.58
1888	7, 10, 13,*	"	684	7.38	2.11	52.41	32.53	5.57
1889	7,	"	706	4.75	1.72	53.63	34.22	5.68
1889	7,	"	734	4.94	1.77	54.04	33.90	5.35
1889	G,	Soil test	766	8.69	2.01	49.62	33.74	5.94
1890	G,	"	904	4.88	2.21	50.59	36.73	5.59
1890	Duplicate of last,	"	906	4.69	2.04	50.83	36.24	6.20
1890	G,	"	944	5.13	1.89	51.79	35.33	5.86
1890	Ga,	"	948	4.74	1.85	51.81	35.63	5.97
1891	7,	Spe. nitrogen	1,019	6.56	1.99	49.32	33.92	8.21
1895	7,	"	1,541	4.77	1.74	53.24	35.10	5.15
1895	7,	"	1,561	3.34	1.82	54.18	35.30	5.36
1896	7,	"	1,740	5.28	2.00	46.22	39.67	6.83
1896	7,	"	1,750	4.89	2.17	51.70	33.30	7.94
	Average,			5.72	1.94	51.06	34.91	6.37
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Nitrate of soda, 320 lbs. (nitrogen, 50 lbs.)</i>							
1888	Plots 8, 11, 14,*	Spe. nitrogen	636	9.31	2.00	47.30	32.96	8.43
1888	8, 11, 14,*	"	656	5.88	1.92	51.71	34.08	6.41
1888	8, 11, 14,*	"	666	7.94	1.91	48.33	34.87	6.95
1888	8, 11, 14,*	"	686	7.44	1.97	51.87	33.09	5.63
1889	8,	"	708	5.19	1.70	52.45	35.24	5.42
1889	8,	"	736	5.25	1.85	52.94	34.17	5.79
1895	8,	"	1,542	5.95	2.13	51.38	34.98	5.56
1895	8,	"	1,562	5.34	1.85	54.33	32.67	5.81
1896	8,	"	1,741	6.91	1.85	46.80	37.08	7.36
1896	8,	"	1,751	5.97	1.99	48.85	35.91	7.28
	Average,			6.52	1.92	50.60	34.50	6.46

* Combined samples (three forms of nitrogen).

TABLE 28. — CONTINUED.

Year.	Plot No. and kind and amount of fertilizer per acre.	Kind of experiment.	Laboratory No.	PERCENTAGE COMPOSITION OF CORN STOVER CALCULATED ON WATER-FREE SUBSTANCE.				
				Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Nitrate of soda, 480 lbs. (nitrogen, 75 lbs.)</i>			Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
1888	Plots 9, 12, 15,*	Spe. nitrogen	638	11.31	0.96	46.90	30.95	8.88
1888	9, 12, 15,*	"	658	7.31	1.88	48.58	35.60	6.69
1888	9, 12, 15,*	"	668	8.69	1.42	45.87	34.49	9.53
1888	9, 12, 15,*	"	688	7.53	1.88	51.55	32.83	6.21
1889	9,	"	710	5.63	1.83	53.21	34.11	5.22
1889	9,	"	738	5.56	2.09	51.76	34.98	5.61
1891	9,	"	1,020	8.06	2.36	49.59	31.67	8.32
1895	9,	"	1,543	4.61	1.86	51.92	36.81	4.80
1895	9,	"	1,563	6.86	1.70	51.97	33.56	5.91
1896	9,	"	1,742	7.04	1.92	46.80	36.69	7.55
1896	9,	"	1,752	8.30	1.95	50.84	31.59	7.32
	Average,			7.35	1.90	49.91	33.93	6.91
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Sul. of ammonia, 120 lbs. (nitrogen, 25 lbs.)</i>							
1889	Plot 10,	Spe. nitrogen	712	5.06	1.85	55.58	32.14	5.37
1889	10,	"	740	5.36	1.79	52.34	34.24	6.27
1895	10,	"	1,544	6.38	1.81	52.24	34.37	5.20
1895	10,	"	1,564	4.42	1.70	54.56	32.71	6.55
1896	10,	"	1,743	5.45	2.27	48.66	36.24	7.25
1896	10,	"	1,753	4.70	2.20	50.70	33.71	8.06
	Average,			5.23	1.94	52.35	33.91	6.57
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Sul. of ammonia, 240 lbs. (nitrogen, 50 lbs.)</i>							
1889	Plot 11,	Spe. nitrogen	714	4.06	1.75	53.60	34.79	5.50
1889	11,	"	742	5.13	1.38	51.03	36.85	5.61
1895	11,	"	1,545	4.42	1.72	54.15	35.04	4.67
1895	11,	"	1,565	4.54	1.73	54.24	32.68	6.81
1896	11,	"	1,744	6.25	1.86	49.13	35.51	7.25
1896	11,	"	1,754	5.81	2.08	49.85	33.75	8.51
	Average,			5.04	1.75	52.00	34.77	6.44
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Sul. of ammonia, 360 lbs. (nitrogen, 75 lbs.)</i>							
1889	Plot 12,	Spe. nitrogen	716	4.94	1.32	51.62	36.50	5.62
1889	12,	"	744	6.44	2.02	51.05	34.75	5.74
1895	12,	"	1,546	5.75	1.71	52.09	35.02	5.43
1895	12,	"	1,566	6.50	1.93	53.46	28.93	9.18
1896	12,	"	1,745	8.54	1.94	48.65	33.27	7.60
1896	12,	"	1,755	6.09	1.81	46.31	37.36	7.53
	Average,			6.53	1.79	50.53	34.30	6.86

* Combined samples (three forms of nitrogen).

TABLE 28. — CONTINUED.

Year.	Plot No. and kind and amount of fertilizer per acre.	Kind of experiment.	Laboratory No.	PERCENTAGE COMPOSITION OF CORN STOVER CALCULATED ON WATER-FREE SUBSTANCE.				
				Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Dried blood, 200 lbs. (nitrogen, 25 lbs.)</i>			Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
1889	Plot 13.	Spe. nitrogen	718	4.56	1.76	54.74	33.31	5.63
1889	13.	"	746	4.69	1.84	52.80	34.09	6.49
	Average,			4.62	1.80	53.82	33.70	6.06
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Dried blood, 400 lbs. (nitrogen, 50 lbs.)</i>							
1889	Plot 14.	Spe. nitrogen	720	4.50	1.92	53.32	34.74	5.52
1889	14.	"	748	3.69	1.97	53.49	34.89	5.96
	Average,			4.10	1.94	53.41	34.81	5.74
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Dried blood, 600 lbs. (nitrogen, 75 lbs.)</i>							
1889	Plot 15.	Spe. nitrogen	722	4.38	1.70	53.82	34.45	5.65
1889	15.	"	750	4.56	2.10	52.05	35.41	5.88
	Average,			4.47	1.90	52.93	34.93	5.77

TABLE 29.—*Effects of nitrogenous fertilizers upon corn (grain, flint varieties).*

[The details of the experiments may be found in the Reports of the Station for the years in which the several experiments were made or for the year following.]

Year.	Plot No. and kind and amount of fertilizer per acre.	Kind of experiment.	YIELDS OF DRY MATTER AND NUTRIENTS IN CORN PER ACRE.					
			Water free substance.	Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
			lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1888	<i>Nothing.</i>							
1888	Plots o and oo, . . .	Soil test	1,043	116	54	839	16	18
1888	o and oo, . . .	Spe. nitrogen	914	119	52	716	13	14
1888	o and oo, . . .	"	662	77	37	526	10	12
1888	o and oo, . . .	"	1,045	126	56	830	17	17
1889	o and oo, . . .	"	233	29	12	183	4	4
1889	o and oo, . . .	"	549	63	33	430	12	11
1889	o and oo, . . .	Soil test	234	26	12	187	5	4
1890	o and oo, . . .	"	2,204	227	143	1,767	33	34
1890	o and oo, . . .	"	259	30	13	206	5	5
1895	o, . . .	Spe. nitrogen	1,646	175	92	1,327	25	28
1895	oo, . . .	"	2,040	214	121	1,638	32	36
1896	o, . . .	"	1,427	143	83	1,147	29	25
1896	oo, . . .	"	1,579	177	84	1,267	24	28
	Average,		1,064	118	61	851	17	18
1888	<i>Nitrate of soda, 160 lbs.</i>							
1888	Plot A, . . .	Soil test	1,596	175	82	1,290	24	25
1888	1, . . .	Spe. nitrogen	992	131	53	777	15	16
1888	1, . . .	"	1,267	147	76	1,001	21	22
1889	1, . . .	"	325	41	17	254	7	6
1889	A, . . .	Soil test	448	54	26	350	10	9
1890	A, . . .	"	2,569	292	130	2,072	37	38
1890	A, . . .	"	667	79	34	532	11	11
	Average,		1,123	131	60	897	18	18
1888	<i>Dissolved Boneblack, 320 lbs.</i>							
1888	Plot B, . . .	Soil test	1,208	138	64	970	17	19
1888	2, . . .	Spe. nitrogen	1,419	190	80	1,106	20	23
1888	2, . . .	"	953	105	53	762	15	18
1889	2, . . .	"	229	30	12	177	5	5
1889	2, . . .	"	648	68	34	521	13	12
1889	B, . . .	Soil test	442	49	23	353	9	8
1890	B, . . .	"	2,006	208	104	1,633	29	32
1890	B, . . .	"	239	26	11	194	4	4
	Average,		893	102	48	715	14	15
1888	<i>Muriate of potash, 160 lbs.</i>							
1888	Plot C, . . .	Soil test	1,113	110	58	909	17	19
1888	3, . . .	Spe. nitrogen	1,241	162	65	972	21	21
1888	3, . . .	"	1,568	161	87	1,270	23	27
1889	3, . . .	"	1,153	118	65	927	21	22
1889	3, . . .	"	608	63	30	491	13	11
1889	C, . . .	Soil test	360	40	19	287	7	7
1890	C, . . .	"	2,347	243	120	1,916	33	35
1890	C, . . .	"	355	30	18	295	7	5
	Average,		1,093	116	58	863	18	18

TABLE 29.—CONTINUED.

Year.	Plot No. and kind and amount of fertilizer per acre.	Kind of experiment.	YIELDS OF DRY MATTER AND NUTRIENTS IN CORN PER ACRE.					
			Water free substance.	Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
	<i>Dissolved boneblack, 320 lbs. Nitrate of soda, 160 lbs.</i>		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1888	Plot D,	Soil test	1,556	186	90	1,229	24	27
1888	4,	Spe. nitrogen	1,617	216	103	1,246	24	28
1888	4,	"	1,087	135	61	853	18	20
1889	4,	"	467	58	32	361	7	9
1889	D,	Soil test	517	59	26	412	10	10
1890	D,	"	2,781	318	146	2,233	41	43
1890	D,	"	845	96	43	677	15	14
	Average,		1,267	153	72	1,002	20	22
	<i>Nitrate of soda, 160 lbs. Muriate of potash, 160 lbs.</i>							
1888	Plot E,	Soil test	1,836	238	100	1,439	28	31
1888	5,	Spe. nitrogen	1,269	167	72	991	20	19
1888	5,	"	1,776	207	100	1,409	29	31
1889	5,	"	1,411	147	88	1,120	26	30
1889	E,	Soil test	463	56	24	364	9	10
1890	E,	"	2,797	285	141	2,288	39	44
1890	E,	"	2,317	209	118	1,919	38	23
	Average,		1,696	187	92	1,361	27	27
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Nitrogen, —</i>							
1888	Plot F,	Soil test	1,256	135	67	1,012	21	21
1888	6, 6a and 6b, . .	Spe. nitrogen	1,884	236	105	1,486	29	29
1888	6, 6a and 6b, . .	"	1,497	148	84	1,216	23	26
1888	6, 6a, 6b, 6c, . .	"	1,308	149	73	1,043	21	22
1889	6, 6a, 6b, 6c, . .	"	808	78	51	650	14	15
1889	6, 6a,	"	773	84	52	603	17	17
1889	F,	Soil test	306	34	15	246	5	6
1890	F,	"	2,159	221	116	1,758	29	35
1890	F,	"	456	38	24	379	8	7
1895	6a,	Spe. nitrogen	2,502	221	155	2,032	51	43
1895	6b,	"	2,825	286	185	2,259	43	52
1896	6a,	"	2,148	201	130	1,735	44	38
1896	6b,	"	2,613	253	140	2,143	33	44
	Average,		1,580	160	92	1,274	26	27
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Nitrogen diff. forms, 25 lbs.</i>							
1888	Plot G,	Soil test	1,900	222	100	1,515	30	33
1888	7, 10, 13, . . .	Spe. nitrogen	2,040	254	116	1,609	29	32
1889	7, 10, 13, . . .	"	2,040	208	111	1,658	30	33
1888	7, 10, 13, . . .	"	1,417	180	77	1,111	26	23
1889	7, 10, 13, . . .	"	1,553	154	108	1,231	29	31
1889	7, 10, 13, . . .	"	1,015	105	58	811	22	19
1889	G,	Soil test	757	83	38	609	14	13
1890	G,	"	2,818	320	150	2,264	39	44

TABLE 29.—CONTINUED.

Year.	Plot No. and kind and amount of fertilizer per acre.	Kind of experiment.	YIELDS OF DRY MATTER AND NUTRIENTS IN CORN PER ACRE.					
			Water free substance.	Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
	<i>Dis. boneblack, etc.</i>		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1890	Plot G, . . .	Soil test	1,802	163	97	1,487	28	26
1895	7, . . .	Spe. nitrogen	3,311	340	210	2,655	49	57
1895	10, . . .	"	3,245	351	237	2,538	52	67
1896	7, . . .	"	3,150	306	195	2,548	47	54
1896	10, . . .	"	2,265	281	153	2,147	35	49
	Average,		2,132	228	127	1,706	33	37
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Nitrogen (diff. forms), 50 lbs.</i>							
1888	Plots 8, 11, 14, . . .	Spe. nitrogen	2,036	270	117	1,586	30	33
1888	8, 11, 14, . . .	"	2,256	237	121	1,826	36	36
1888	8, 11, 14, . . .	"	1,622	199	90	1,280	27	26
1889	8, 11, 14, . . .	"	2,305	227	154	1,839	42	43
1889	8, 11, 14, . . .	"	1,267	139	71	1,006	28	23
1895	8, . . .	"	3,565	380	224	2,847	53	61
1895	11, . . .	"	3,555	414	256	2,760	55	70
1896	8, . . .	"	3,434	354	220	2,747	51	62
1896	11, . . .	"	3,463	387	230	2,721	57	68
	Average,		2,611	290	165	2,068	42	47
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Nitrogen (diff. forms), 75 lbs.</i>							
1888	Plots 9, 12, 15, . . .	Spe. nitrogen	1,950	280	111	1,499	27	33
1888	9, 12, 15, . . .	"	2,420	284	136	1,922	37	41
1888	9, 12, 15, . . .	"	1,442	190	81	1,124	24	23
1889	9, 12, 15, . . .	"	2,429	246	157	1,933	45	48
1889	9, 12, 15, . . .	"	1,375	151	84	1,083	29	28
1895	9, . . .	"	3,585	431	227	2,807	56	64
1895	12, . . .	"	3,517	434	248	2,709	54	72
1896	9, . . .	"	3,808	434	237	3,017	52	68
1896	12, . . .	"	3,508	430	211	2,750	51	66
	Average,		2,670	320	166	2,094	42	49

TABLE 30.—*Effects of nitrogenous fertilizers upon corn stover (flint varieties).*

[The details of the experiments may be found in the Reports of the Station for the years in which the several experiments were made or for the year following.]

Year.	Plot No. and kind and amount of fertilizer per acre.	Kind of experiment.	YIELDS OF DRY MATTER AND NUTRIENTS IN CORN STOVER PER ACRE.					
			Water free substance.	Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
	<i>Nothing.</i>		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1888	Plots o and oo, . . .	Soil test	1,075	51	18	544	400	62
1888	o and oo, . . .	Spe. nitrogen	958	96	25	463	298	76
1888	o and oo, . . .	"	1,263	104	31	661	388	78
1888	o and oo, . . .	"	1,556	111	25	751	558	111
1889	o and oo, . . .	"	568	45	10	276	207	31
1889	o and oo, . . .	"	1,120	72	23	581	380	64
1889	o and oo, . . .	Soil test	549	40	12	288	180	31
1890	o and oo, . . .	"	1,711	85	30	859	647	91
1890	o and oo, . . .	"	762	72	13	397	242	37
1895	o, . . .	Spe. nitrogen	2,254	132	37	1,172	808	104
1895	oo, . . .	"	1,738	110	31	927	552	118
1896	o, . . .	"	1,775	128	28	873	612	133
1896	oo, . . .	"	1,102	75	19	543	383	82
	Average,		1,264	86	23	641	435	78
	<i>Nitrate of soda, 160 lbs.</i>							
1888	Plot A, . . .	Soil test	1,415	80	30	711	519	75
1888	1, . . .	Spe. nitrogen	1,006	98	24	494	320	70
1888	1, . . .	"	1,819	128	32	961	596	102
1889	1, . . .	"	653	63	11	356	194	29
1889	A, . . .	Soil test	640	55	12	327	211	36
1890	A, . . .	"	1,938	103	41	962	735	97
1890	A, . . .	"	1,161	112	19	600	372	58
	Average,		1,233	91	24	630	421	67
	<i>Dissolved boneblack, 320 lbs.</i>							
1888	Plot B, . . .	Soil test	1,434	64	26	735	526	83
1888	2, . . .	Spe. nitrogen	1,273	120	29	610	410	104
1888	2, . . .	"	1,483	103	33	777	472	98
1889	2, . . .	"	568	53	10	300	175	30
1889	2, . . .	"	1,613	76	33	855	562	87
1889	B, . . .	Soil test	755	58	15	391	249	42
1890	B, . . .	"	1,563	68	35	788	589	83
1890	B, . . .	"	654	66	10	330	212	36
	Average,		1,168	76	24	598	399	70
	<i>Muriate of potash, 160 lbs.</i>							
1888	Plot C, . . .	Soil test	1,207	52	25	615	444	71
1888	3, . . .	Spe. nitrogen	1,039	106	23	514	324	72
1888	3, . . .	"	1,749	125	38	885	568	133
1889	3, . . .	"	1,329	75	26	757	398	73
1889	3, . . .	"	1,206	54	22	671	393	66
1889	C, . . .	Soil test	699	49	14	363	232	41
1890	C, . . .	"	1,815	81	37	895	691	111
1890	C, . . .	"	1,520	130	47	761	500	82
	Average,		1,321	84	29	683	444	81

TABLE 30. — CONTINUED.

Year.	Plot No. and kind and amount of fertilizer per acre.	Kind of experiment.	YIELDS OF DRY MATTER AND NUTRIENTS IN CORN STOVER PER ACRE.					
			Water free substance.	Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
	<i>Dissolved boneblack, 320 lbs.</i>		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
	<i>Nitrate of soda, 160 lbs.</i>							
1888	Plot D,	Soil test	1,665	91	32	855	601	86
1888	4,	Spe. nitrogen	1,345	119	28	671	441	86
1888	4,	"	1,965	176	34	1,011	631	113
1889	4,	"	774	72	13	415	234	40
1889	D,	Soil test	762	60	16	391	251	44
1890	D,	"	2,145	105	43	1,101	790	106
1890	D,	"	1,261	114	19	640	428	60
	Average,		1,417	105	26	726	482	76
	<i>Muriate of potash, 160 lbs.</i>							
	<i>Nitrate of soda, 160 lbs.</i>							
1888	Plot E,	Soil test	1,720	95	31	853	637	104
1888	5,	Spe. nitrogen	1,236	115	27	589	410	95
1888	5,	"	1,726	133	37	881	567	108
1889	5,	"	1,758	97	31	922	603	105
1889	E,	Soil test	802	67	15	413	263	44
1890	E,	"	1,856	89	38	922	698	109
1890	E,	"	2,022	116	42	1,052	704	108
	Average,		1,589	102	32	805	555	96
	<i>Dissolved boneblack, 320 lbs.</i>							
	<i>Muriate of potash, 160 lbs.</i>							
	<i>Nitrogen, —</i>							
1888	Plot F,	Soil test	1,459	64	26	746	533	90
1888	6, 6a, 6b, . . .	Spe. nitrogen	1,522	134	31	725	509	123
1888	6, 6a, 6b, 6c, .	"	1,894	116	50	976	615	137
1888	6, 6a, 6b, 6c, .	"	1,517	107	24	737	535	114
1889	6, 6a, 6b, 6c, .	"	1,349	63	30	763	420	73
1889	6, 6a,	"	1,559	79	27	857	496	100
1889	F,	Soil test	793	52	20	414	256	51
1890	F,	"	2,038	82	39	1,027	766	124
1890	F,	"	1,889	80	50	1,044	619	96
1895	6a,	Spe. nitrogen	2,920	106	60	1,595	967	192
1895	6b,	"	3,004	110	62	1,641	994	197
1896	6a,	"	2,379	124	52	1,181	849	173
1896	6b,	"	2,065	96	40	1,040	717	172
	Average,		1,876	93	39	980	637	126
	<i>Dissolved boneblack, 320 lbs.</i>							
	<i>Muriate of potash, 160 lbs.</i>							
	<i>Nitrogen (diff. forms) 25 lbs.</i>							
1888	Plot G,	Soil test	1,897	91	30	971	689	116
1888	7, 10, 13, . . .	Spe. nitrogen	1,341	108	29	659	444	101
1888	7, 10, 13, . . .	"	2,152	133	44	1,107	707	161
1888	7, 10, 13, . . .	"	1,619	133	30	756	577	123
1889	7, 10, 13, . . .	"	1,618	78	29	886	538	87
1889	7, 10, 13, . . .	"	1,791	89	32	952	610	108
1889	G,	Soil test	996	87	20	494	336	59
1890	G,	"	2,130	102	45	1,080	777	126
1890	G,	Soil test	2,775	142	52	1,438	980	163
1895	7,	Spe. nitrogen	3,001	167	53	1,583	1,043	155
1895	10,	"	2,852	111	50	1,550	971	170

TABLE 30. — CONTINUED.

Year.	Plot No. and kind and amount of fertilizer per acre.	Kind of experiment.	YIELDS OF DRY MATTER AND NUTRIENTS IN CORN STOVER PER ACRE.					
			Water free substance.	Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
	<i>Dissolved boneblack, etc.</i>		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1896	7,	"	3,271	176	70	1,551	1,241	233
1896	10,	"	2,495	120	55	1,276	836	208
	Average,		2,149	118	41	1,100	750	139
	<i>Dissolved boneblack, 320 lbs.</i>							
	<i>Muriate of potash, 160 lbs.</i>							
	<i>Nitrogen (diff. forms), 50 lbs.</i>							
1888	Plots 8, 11, 14, . .	Spe. nitrogen	1,629	152	53	769	537	138
1888	8, 11, 14,	"	2,317	136	44	1,197	791	149
1888	8, 11, 14,	"	1,776	141	34	859	619	123
1889	8, 11, 14,	"	2,015	93	36	1,070	704	112
1889	8, 11, 14,	"	1,784	84	31	938	629	104
1895	8,	"	2,930	152	57	1,545	1,026	150
1895	11,	"	2,802	138	50	1,521	916	177
1896	8,	"	3,038	200	57	1,456	1,103	222
1896	11,	"	2,152	127	44	1,061	750	170
	Average,		2,271	136	45	1,157	786	149
	<i>Dissolved boneblack, 320 lbs.</i>							
	<i>Muriate of potash, 160 lbs.</i>							
	<i>Nitrogen (diff. forms), 75 lbs.</i>							
1888	Plots 9, 12, 15, . .	Spe. nitrogen	1,461	165	29	685	452	130
1888	9, 12, 15,	"	2,343	171	44	1,139	834	155
1888	9, 12, 15,	"	1,721	150	24	789	594	164
1889	9, 12, 15,	"	2,026	100	32	1,072	710	112
1889	9, 12, 15,	"	1,717	93	36	887	602	99
1895	9,	"	3,340	172	59	1,727	1,192	170
1895	12,	"	2,974	199	54	1,567	929	225
1896	9,	"	2,919	227	56	1,394	1,021	221
1896	12,	"	2,869	219	54	1,394	989	213
	Average,		2,372	166	43	1,184	814	165

Explanation of Tables 31, 32, 33, and 34.—Tables 31-32 show the individual analyses of samples of oats (grain) and oat straw from all the individual experiments with this crop. Samples of the crops from both soil tests and special nitrogen experiments are analyzed, and the results averaged as already explained, and the averages given in the summary Tables 15 and 16 on pages 142 and 144 in the discussion.

Tables 33 and 34 show the yields of water-free substance and of various food constituents per acre, estimated in the manner for the other crops. The averages in bold face type in these tables are the values used in the summary Table 17 on page 146, in the discussion of the results.

TABLE 31.—*Effects of nitrogenous fertilizers upon oats (grain.)*

[The details of the analyses may be found in the Reports of the Station for the years in which the several experiments were made or for the succeeding year.]

Year.	Plot No. and kind and amount of fertilizer per acre.	Kind of experiment.	Laboratory No.	PERCENTAGE COMPOSITION OF GRAIN CALCULATED ON WATER-FREE SUBSTANCE				
				Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
	<i>Nothing.</i>			Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
1890	Plot o,	Spe. nitrogen	837	14.25	5.48	62.52	14.33	3.42
1890	oo,	"	839	13.60	5.63	62.75	14.61	3.41
1890	ooo,	"	841	13.12	5.47	62.42	15.96	3.25
1892	o,	Soil test	1,073	15.75	5.88	64.41	10.35	3.51
1892	oo,	"	1,074	14.81	5.65	67.46	8.39	3.65
1892	ooo,	"	1,075	13.75	5.43	66.50	10.59	3.73
1892	o,	Spe. nitrogen	1,085	16.31	6.21	66.32	8.02	3.14
1892	oo,	"	1,086	15.68	6.48	66.58	8.16	3.20
1896	o,	Soil test	1,715	13.17	6.34	68.81	8.51	3.17
1896	oo,	"	1,716	12.90	6.26	67.97	9.40	3.47
1896	ooo,	"	1,717	13.13	5.90	67.91	9.77	3.22
	Average,		.....	14.22	5.88	65.79	10.74	3.37
	<i>Nitrate of soda, 160 lbs.</i>							
1892	Plot A,	Soil test	1,076	15.31	5.64	65.75	9.90	3.40
1896	A,	"	1,706	14.85	6.55	68.13	7.23	3.24
	Average,		.....	15.08	6.10	66.94	8.56	3.32
	<i>Dis. boneblack, 320 lbs.</i>							
1892	Plot B,	Soil test	1,077	14.19	5.62	66.80	9.78	3.61
1896	B,	"	1,707	12.31	6.46	68.97	8.67	3.50
	Average,		.....	13.25	6.04	67.88	9.23	3.66
	<i>Muriate of potash, 160 lbs.</i>							
1892	Plot C,	Soil test	1,078	14.75	5.76	67.01	9.05	3.43
1896	C,	"	1,708	12.67	6.27	68.58	9.12	3.36
	Average,		.....	13.71	6.02	67.79	9.08	3.40
	<i>Dis. boneblack, 320 lbs.</i>							
	<i>Nitrate of soda, 160 lbs.</i>							
1892	Plot D,	Soil test	1,079	14.63	6.06	67.12	8.98	3.21
1896	D,	"	1,709	12.74	6.36	70.56	7.32	3.02
	Average,		.....	13.68	6.21	68.84	8.15	3.12
	<i>Muriate of potash, 160 lbs.</i>							
	<i>Nitrate of soda, 160 lbs.</i>							
1892	Plot E,	Soil test	1,080	14.81	5.77	66.24	9.82	3.35
1896	E,	"	1,710	14.12	6.52	68.77	7.61	3.22
	Average,		.....	14.46	6.15	67.50	8.72	3.17
	<i>Dis. boneblack, 320 lbs.</i>							
	<i>Muriate of potash, 160 lbs.</i>							
	<i>Nitrogen, —</i>							
1890	Plot 6a,	Spe. nitrogen	843	14.38	5.63	63.57	13.22	3.20
1890	6b,	"	845	14.25	5.93	65.19	11.81	3.12
1892	F,	Soil test	1,081	13.68	5.39	67.14	10.25	3.54
1892	6,	Spe. nitrogen	1,087	15.68	6.09	67.26	7.77	3.22

TABLE 31.—CONTINUED.

Year.	Plot No. and kind and amount of fertilizer per acre.	Kind of experiment.	Laboratory No.	PERCENTAGE COMPOSITION OF OATS CALCULATED ON WATER-FREE SUBSTANCE.				
				Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
	<i>Dis. boneblack, etc.</i>			Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
1892	Plot 6a, . . .	Spe. nitrogen	1,088	14.69	6.30	67.28	8.52	3.21
1892	6b, . . .	"	1,089	16.19	6.59	68.17	6.13	2.92
1892	6c, . . .	"	1,090	17.19	6.42	66.59	6.75	3.05
1896	F, . . .	Soil test	1,711	12.02	6.45	71.03	7.48	3.02
	Average,		.....	14.76	6.10	67.03	8.99	3.12
	<i>Dis. boneblack, 320 lbs. Muriate of potash, 160 lbs. Nitr. of soda, 160 lbs. (nitro- gen, 25 lbs.)</i>							
1890	Plot 7, . . .	Spe. nitrogen	847	15.70	6.22	65.10	10.13	2.85
1892	G, . . .	Soil test	1,082	14.56	5.78	68.34	8.22	3.10
1892	7, . . .	Spe. nitrogen	1,091	16.56	6.00	66.83	7.70	2.91
1896	G, . . .	Soil test	1,712	11.89	6.04	69.29	9.78	3.00
	Average,		.....	14.68	6.01	67.39	8.96	2.96
	<i>Dis. boneblack, 320 lbs. Muriate of potash, 160 lbs. Nitr. of soda, 320 lbs. (nitro- gen, 50 lbs.)</i>							
1890	Plot 8, . . .	Spe. nitrogen	849	16.31	6.03	64.52	10.49	2.65
1892	8, . . .	"	1,092	16.38	5.54	65.65	9.45	2.98
	Average,		.....	16.34	5.79	65.08	9.97	2.82
	<i>Dis. boneblack, 320 lbs. Muriate of potash, 160 lbs. Nitr. of soda, 480 lbs. (nitro- gen, 75 lbs.)</i>							
1890	Plot 9, . . .	Spe. nitrogen	851	16.75	6.14	63.72	10.74	2.65
1892	9, . . .	"	1,093	17.19	5.22	64.14	10.37	3.08
	Average,		.....	16.97	5.68	63.93	10.55	2.87
	<i>Dis. boneblack, 320 lbs. Muriate of potash, 160 lbs. Sul. of ammo., 120 lbs. (nitro- gen, 25 lbs.)</i>							
1890	Plot 10, . . .	Spe. nitrogen	853	13.94	6.05	64.90	12.25	2.86
	<i>Dis. boneblack, 320 lbs. Muriate of potash, 160 lbs. Sul. of ammo., 240 lbs. (nitro- gen, 50 lbs.)</i>							
1890	Plot 11, . . .	Spe. nitrogen	855	15.12	6.14	64.45	11.59	2.70
	<i>Dis. boneblack, 320 lbs. Muriate of potash, 160 lbs. Sul. of ammo., 360 lbs. (nitro- gen, 75 lbs.)</i>							
1890	Plot 12, . . .	Spe. nitrogen	857	15.00	5.86	62.38	13.84	2.92

TABLE 31.—CONTINUED.

Year.	Plot No. and kind and amount of fertilizer per acre.	Kind of experiment.	Laboratory No.	PERCENTAGE COMPOSITION OF OATS CALCULATED ON WATER-FREE SUBSTANCE				
				Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
	<i>Dis. boneblack, 320 lbs. Muriate of potash, 160 lbs. Dried blood, 200 lbs. (nitrogen, 25 lbs.)</i>			Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
1890	Plot 13,	Spe. nitrogen	859	14.50	6.00	64.85	11.88	2.77
1892	13,	"	1,094	15.50	5.68	66.73	8.90	3.19
	Average,		.....	15.00	5.84	65.79	10.39	2.98
	<i>Dis. boneblack, 320 lbs. Muriate of potash, 160 lbs. Dried blood, 400 lbs. (nitrogen, 50 lbs.)</i>							
1890	Plot 14,	Spe. nitrogen	861	14.06	5.85	65.22	12.13	2.74
1892	14,	"	1,095	15.88	5.77	66.33	8.97	3.05
	Average,		.....	14.97	5.81	65.77	10.55	2.90
	<i>Dis. boneblack, 320 lbs. Muriate of potash, 160 lbs. Dried blood, 600 lbs. (nitrogen, 75 lbs.)</i>							
1890	Plot 15,	Spe. nitrogen	863	14.69	5.98	64.91	11.74	2.63
1892	15,	"	1,096	17.06	5.91	66.50	7.59	2.42
	Average,		... ..	15.87	5.95	65.70	9.67	2.53

TABLE 32.—*Effects of nitrogenous fertilizers upon oat straw.*

[The details of the analyses may be found in the Reports of the Station for the years in which the several experiments were made or for the succeeding year.]

Year.	Plot No. and kind and amount of fertilizer per acre.	Kind of experiment.	Laboratory No.	PERCENTAGE COMPOSITION OF OAT STRAW CALCULATED ON WATER-FREE SUBSTANCE.				
				Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
				Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
	<i>Nothing.</i>							
1890	Plot o,	Spe. nitrogen	836	8.63	3.90	48.21	34.49	4.77
1890	oo,	"	838	8.31	3.09	48.99	35.26	4.35
1890	ooo,	"	840	9.00	3.44	48.67	34.71	4.18
1892	o,	"	1,097	5.44	3.02	44.98	40.39	6.17
1892	oo,	"	1,098	5.56	3.37	46.16	39.35	5.56
	Average,		....	7.39	3.36	47.40	36.84	5.01
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Nitrogen,—</i>							
1890	Plot 6a,	Spe. nitrogen	842	6.13	3.40	48.35	37.15	4.97
1890	6b,	"	844	5.94	3.42	49.04	33.31	4.29
1892	6,	"	1,099	4.81	3.01	44.50	41.36	6.32
1892	6a,	"	1,100	4.81	2.87	46.02	40.45	5.85
1892	6b,	"	1,101	3.60	2.90	45.68	41.54	6.19
1892	6c,	"	1,102	4.88	2.69	44.80	41.88	5.66
	Average,		...	5.04	3.05	46.41	39.95	5.55
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Nitrate of soda, 160 lbs. (nitro- gen, 25 lbs.)</i>							
1890	Plot 7,	Spe. nitrogen	846	5.06	3.84	47.82	38.52	4.76
1892	7,	"	1,103	4.19	2.49	45.07	42.78	5.47
	Average,		...	4.63	3.16	46.44	40.65	5.12
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Nitrate of soda, 320 lbs. (nitro- gen, 50 lbs.)</i>							
1890	Plot 8,	Spe. nitrogen	848	5.25	3.32	48.29	38.49	4.65
1892	8,	"	1,104	4.56	2.57	44.66	42.70	5.51
	Average,		...	4.90	2.95	46.47	40.60	5.08
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Nitrate of soda, 480 lbs. (nitro- gen, 75 lbs.)</i>							
1890	Plot 9,	Spe. nitrogen	850	6.00	3.56	47.23	38.19	5.02
1892	9,	"	1,105	6.06	2.37	43.55	42.28	5.74
	Average,		....	6.03	2.97	45.39	40.23	5.38
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Sulphate of ammonia, 120 lbs. (nitrogen, 25 lbs.)</i>							
1890	Plot 10,	Spe. nitrogen	852	5.69	3.60	49.56	36.61	4.54

TABLE 32.—CONTINUED.

Year.	Plot No. and kind and amount of fertilizer per acre.	Kind of experiment.	Laboratory No.	PERCENTAGE COMPOSITION OF OAT STRAW CALCULATED ON WATER-FREE SUBSTANCE				
				Protein.	Fat.	Nitrogen free extract.	Fiber.	As.
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Sulphate of ammonia, 240 lbs. (nitrogen, 50 lbs.)</i>			Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
1890	Plot 11,	Spe. nitrogen	854	6.81	3.38	48.66	37.00	4.15
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Sulphate of ammonia, 360 lbs. (nitrogen, 75 lbs.)</i>							
1890	Plot 12,	Spe. nitrogen	856	7.50	3.18	48.15	37.05	4.12
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Dried blood, 200 lbs. (nitrogen, 25 lbs.)</i>							
1890	Plot 13,	Spe. nitrogen	858	5.63	3.19	48.52	38.27	4.31
1892	13,	"	1,106	3.88	2.82	44.52	43.24	5.34
	Average,		....	4.75	3.01	46.52	40.75	4.97
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Dried blood, 400 lbs. (nitrogen, 50 lbs.)</i>							
1890	Plot 14,	Spe. nitrogen	860	5.25	3.17	48.95	38.12	4.31
1892	14,	"	1,107	4.38	2.73	45.32	41.91	5.56
	Average,		....	4.82	2.95	47.13	40.02	5.08
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Dried blood, 600 lbs. (nitrogen, 75 lbs.)</i>							
1890	Plot 15,	Spe. nitrogen	862	5.38	3.19	48.86	38.12	4.45
1892	15,	"	1,108	5.17	2.88	46.20	40.62	5.13
	Average,		....	5.27	3.04	47.53	39.37	4.79

TABLE 33.—*Effects of nitrogenous fertilizers upon oats (grain).*

The details of the experiments may be found in the Reports of the Station for the years in which the several experiments were made or for the year following.]

Year.	Plot No. and kind and amount of fertilizer per acre.	Kind of experiment.	YIELDS OF DRY MATTER AND NUTRIENTS IN OATS PER ACRE.					
			Water free substance.	Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
	<i>Nothing.</i>		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1890	Plot 0,	Spe. nitrogen	102	15	6	62	15	4
1890	00,	"	49	7	3	30	7	2
1890	000,	"	87	11	5	54	14	3
1892	0,	"	600	97	37	399	48	19
1892	00,	"	449	70	29	299	37	14
1892	0,	Soil test	786	124	46	507	81	28
1892	00,	"	658	98	37	444	55	24
1892	000,	"	637	88	35	423	67	24
	Average,		421	64	25	277	41	15
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Nitrogen, —</i>							
1890	Plot 6a,	Spe. nitrogen	254	37	14	161	34	8
1890	6b,	"	324	46	19	212	38	9
1892	6,	"	523	82	32	351	41	17
1892	6a,	"	417	61	26	281	36	13
1892	6b,	"	515	83	34	351	32	15
1892	6c,	"	547	94	35	364	37	17
	Average,		430	67	27	287	36	13
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Nitrogen (diff. forms), 25 lbs.</i>							
1890	Plots 7, 10, 13, . .	Spe. nitrogen	366	55	23	237	41	10
1892	7, 13,	"	676	109	40	450	56	21
	Average,		521	82	32	344	49	16
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Nitrogen (diff. forms), 50 lbs.</i>							
1890	Plots 8, 11, 14, . .	Spe. nitrogen	428	66	26	276	49	11
1892	8, 14,	"	697	113	40	458	65	21
	Average,		563	90	33	367	57	16
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Nitrogen (diff. forms) 75 lbs.</i>							
1890	Plots 9, 12, 15, . .	Spe. nitrogen	528	82	32	337	63	14
1892	9, 15,	"	724	124	40	472	66	22
	Average,		626	103	36	405	65	18

TABLE 34.—*Effects of nitrogenous fertilizers upon oat straw.*

[The details of the experiments may be found in the Reports of the Station for the years in which the several experiments were made or for the year following.]

Year.	Plot No. and kind and amount of fertilizer per acre.	Kind of experiment.	YIELD OF DRY MATTER AND NUTRIENTS IN OAT STRAW PER ACRE.					
			Water free substance.	Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
	<i>Nothing.</i>		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1890	Plot o, . . .	Spe. nitrogen	165	14	6	80	57	8
1890	oo, . . .	"	114	10	4	55	40	5
1890	ooo, . . .	"	222	20	8	108	77	9
1892	o, . . .	"	1,292	70	39	581	522	80
1892	oo, . . .	"	933	52	32	430	367	52
	Average,		545	33	18	251	213	31
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Nitrogen,—</i>							
1890	Plot 6a, . . .	Spe. nitrogen	448	28	15	217	166	22
1890	6b, . . .	"	491	29	17	241	183	21
1892	6, . . .	"	987	47	30	440	408	62
1892	6a, . . .	"	1,312	63	38	603	531	77
1892	6b, . . .	"	1,241	46	36	566	516	77
1892	6c, . . .	"	1,034	50	28	464	434	58
	Average,		919	44	27	422	373	53
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Nitrogen (different forms), 25 lbs.</i>							
1890	Plots 7, 10, 13, . . .	Spe. nitrogen	770	42	28	374	291	35
1892	7, 13, . . .	"	1,757	72	47	786	755	97
	Average,		1,264	57	38	580	523	66
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Nitrogen (different forms), 50 lbs.</i>							
1890	Plots 8, 11, 14, . . .	Spe. nitrogen	911	52	30	442	346	41
1892	8, 14, . . .	"	2,010	90	53	904	850	113
	Average,		1,461	71	42	673	598	77
	<i>Dissolved boneblack, 320 lbs. Muriate of potash, 160 lbs. Nitrogen (different forms), 75 lbs.</i>							
1890	Plots 9, 12, 15, . . .	Spe. nitrogen	1,235	77	41	594	467	56
1892	9, 15, . . .	"	2,567	146	67	1,146	1,067	141
	Average,		1,901	112	54	870	767	99

Explanation of Table 35. — This table shows the results of the individual analyses of samples of different species of grasses grown on plots which received different quantities of nitrogen. These grasses were grown on small plots, mostly one-eightieth of an acre in size, in the Station grass garden. Owing to the small size of the plots no effort was made to determine the weight of the yield per acre. The general plan of the experiments was that of special nitrogen experiments, but with fewer plots. In most cases there were four plots for each kind of grass, and the experiments were continued on the same plots for three to seven years. The plots included in each experiment were generally a "nothing" plot, a "mineral" plot, a plot with the one-third ration, and a plot with the full ration of nitrogen, in addition to the minerals. In a few cases samples were taken from still smaller plots which were divided into two parts, one of which was supplied with the one-third and the other with the full ration of nitrogen.

The samples were usually taken at the time the grasses were in blossom, or soon after, and care was exercised to exclude from the sample of any particular grass any of the other species of grass or any clover that might be growing on the plot. The averages given in this table in bold face type appear in the summary Table II, on page 134, in the discussion.

TABLE 35.—*Effect of nitrogenous fertilizers upon different species of grasses.*

[The details of the analyses may be found in the Reports of the Station for the years in which the several experiments were made or for the succeeding year.]

Year.	Plot No. and kind and amount of fertilizer per acre.	Condition of growth when harvested.	Laboratory No.	PERCENTAGE COMPOSITION OF DIFFERENT SPECIES OF GRASSES CALCULATED ON WATER-FREE SUBSTANCE.				
				Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
				Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
TIMOTHY. (PHLEUM PRATENSE.)								
<i>Nothing.</i>								
1891	Plot 0,	Early bloom	1,005	9.19	2.93	49.09	31.32	7.47
1892	0,	Seed forming	1,060	6.75	3.40	49.87	33.84	6.14
1893	0,	Early bloom	1,230	7.92	3.28	48.31	34.44	6.05
1894	0,	Late bloom	1,355	7.25	3.18	47.77	36.19	5.61
1896	0,	Seed forming	1,649	8.51	4.46	51.42	29.22	6.39
1897	0,	Seed forming	1,848	5.93	2.78	48.81	37.51	4.97
1898	0,	Full bloom	1,971	7.58	3.14	49.94	34.15	5.19
	Average,		.....	7.59	3.31	49.32	33.81	5.97
<i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Nitrogen, —</i>								
1891	Plot 6,	Early bloom	1,004	9.06	2.94	48.46	31.78	7.76
1892	6,	Seed forming	1,061	6.25	2.97	49.17	35.18	6.43
1893	6,	Early bloom	1,231	7.72	2.80	47.95	35.06	6.47
1894	6,	Late bloom	1,356	6.79	2.67	52.55	31.69	6.30
1896	6,	Seed forming	1,654	6.41	3.32	51.68	32.68	5.91
1897	6,	Seed forming	1,847	6.26	3.03	52.12	32.77	5.82
1898	6,	Full bloom	1,972	6.72	2.82	49.08	35.29	6.09
	Average,		.....	7.03	2.94	50.14	33.49	6.40
<i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Nitr. of soda, 160 lbs. (nitrogen, 25 lbs.)</i>								
1891	Plot 7,	Early bloom	1,006	9.12	3.78	46.90	32.96	7.24
1892	7,	Seed forming	1,062	7.06	2.98	49.43	34.41	6.12
1893	7,	Early bloom	1,232	8.99	2.77	46.27	35.78	6.19
1894	7,	Late bloom	1,357	6.14	3.18	47.03	37.94	5.71
1896	7,	Seed forming	1,659	6.82	2.95	50.82	33.71	5.70
1897	7,	Seed forming	1,849	5.64	2.81	49.82	36.46	5.27
1898	7,	Full bloom	1,972	7.50	2.79	44.90	38.98	5.83
	Average,		.....	7.32	3.04	47.88	35.75	6.01
<i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Nitr. of soda, 480 lbs. (nitrogen, 75 lbs.)</i>								
1891	Plot 9,	Early bloom	1,007	10.44	3.62	48.07	31.12	6.75
1892	9,	Seed forming	1,063	10.69	3.19	46.95	32.84	6.33
1893	9,	Early bloom	1,233	11.93	2.98	44.58	34.39	6.12
1894	9,	Late bloom	1,358	7.82	3.60	45.67	37.42	5.49
1896	9,	Seed forming	1,664	7.89	3.13	51.91	32.12	4.95
1897	9,	Seed forming	1,850	7.26	2.97	46.52	37.00	6.25
1898	9,	Full bloom	1,974	9.08	3.31	48.25	34.04	5.32
	Average,		.....	9.30	3.26	47.42	34.13	5.89

TABLE 35.—CONTINUED.

Year.	Plot No. and kind and amount of fertilizer per acre.	Condition of growth when harvested.	Laboratory No.	PERCENTAGE COMPOSITION OF DIFFERENT SPECIES OF GRASSES CALCULATED ON WATER-FREE SUBSTANCE.				
				Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
	ORCHARD GRASS. (DACTYLIS GLOMERATA.)							
	<i>Nothing.</i>			Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
1891	Plot o,	Seed forming	1,001	8.37	5.42	44.90	32.37	8.94
1892	o,	Seed forming	1,044	8.44	4.16	45.49	32.87	9.04
1893	o,	Late bloom	1,226	8.30	3.56	44.71	36.38	7.05
1894	o,	Seed forming	1,357	7.54	3.04	44.63	36.98	7.81
1896	o,	Seed forming	1,650	10.09	5.25	43.65	31.47	9.54
1897	o,	Late bloom	1,852	7.90	2.99	46.98	33.87	8.26
1898	o,	Late bloom	1,963	6.25	3.41	48.29	35.32	6.73
	Average,		.....	8.13	3.98	45.52	34.18	8.19
	<i>Dis. boneblack, 310 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Nitrogen, —</i>							
1891	Plot 6,	Seed forming	1,000	9.56	4.66	45.20	30.92	9.66
1892	6,	Seed forming	1,045	8.19	4.05	44.86	33.57	9.33
1893	6,	Late bloom	1,227	7.73	3.45	45.01	36.13	7.68
1894	6,	Seed forming	1,360	7.17	2.83	43.21	38.14	8.65
1896	6,	Seed forming	1,655	9.53	5.03	42.67	32.40	10.37
1897	6,	Late bloom	1,851	6.83	2.90	44.32	37.31	8.64
1898	6,	Late bloom	1,964	6.38	3.12	46.62	35.96	7.92
	Average,		.....	7.91	3.72	44.56	34.92	8.89
	<i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Nitr. of soda, 160 lbs. (nitrogen, 25 lbs.)</i>							
1891	Plot 7,	Seed forming	1,002	8.75	4.55	44.30	32.83	9.57
1892	7,	Seed forming	1,046	11.50	5.47	41.80	31.55	9.68
1893	7,	Late bloom	1,228	11.97	3.86	42.08	33.42	8.67
1894	7,	Seed forming	1,361	7.91	3.55	43.67	36.27	8.60
1896	7,	Seed forming	1,660	10.07	4.62	39.85	35.43	10.03
1897	7,	Late bloom	1,853	8.78	2.80	45.74	33.83	8.85
1898	7,	Late bloom	1,965	8.17	3.60	45.46	33.55	9.22
	Average,		.....	9.60	4.06	43.27	33.84	9.23
	<i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Nitr. of soda, 180 lbs. (nitrogen, 75 lbs.)</i>							
1891	Plot 9,	Seed forming	1,003	9.62	4.93	44.96	30.82	9.67
1892	9,	Seed forming	1,047	15.50	5.45	38.30	31.61	9.14
1893	9,	Late bloom	1,229	16.80	4.45	38.64	31.23	8.88
1894	9,	Seed forming	1,362	10.61	3.45	41.61	36.24	8.09
1896	9,	Seed forming	1,665	11.83	5.38	42.55	31.67	8.57
1897	9,	Late bloom	1,854	13.01	3.89	39.80	34.41	8.89
1898	9,	Late bloom	1,966	11.05	4.08	43.44	32.84	8.59
	Average,		.....	12.63	4.52	41.33	32.69	8.83

TABLE 35.—CONTINUED.

Year.	Plot No. and kind and amount of fertilizer per acre.	Condition of growth when harvested.	Laboratory No.	PERCENTAGE COMPOSITION OF DIFFERENT SPECIES OF GRASSES CALCULATED ON WATER-FREE SUBSTANCE.				
				Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
	TALL MEADOW FESCUE GRASS. (FESTUCA ELATIOR.)							
	<i>Nothing.</i>			Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
1893	Plot 0,	Full bloom	1,222	7.47	2.63	46.32	36.48	7.10
1894	0,	Seed forming	1,351	5.94	2.44	40.19	44.40	7.03
1896	0,	Seed forming	1,651	9.36	4.85	48.59	28.79	8.41
1897	0,	Late bloom	1,856	6.30	2.57	44.17	40.24	6.72
1898	0,	Late bloom	1,975	6.75	2.54	52.77	31.61	6.33
	Average,		.....	7.16	3.01	46.41	36.30	7.12
	<i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Nitrogen, —</i>							
1893	Plot 6,	Full bloom	1,223	7.76	2.85	46.04	36.04	7.31
1894	6,	Seed forming	1,352	5.98	2.39	50.25	34.13	7.25
1896	6,	Seed forming	1,656	9.24	3.86	50.10	28.97	7.83
1897	6,	Late bloom	1,855	5.99	2.52	48.03	35.74	7.72
1898	6,	Late bloom	1,976	6.85	2.69	49.28	33.57	7.61
	Average,		.....	7.16	2.86	48.74	33.69	7.55
	<i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Nitr. of soda, 160 lbs. (nitrogen, 25 lbs.)</i>							
1891	Plot 7,	Seed forming	1,011	7.50	3.01	51.84	31.31	6.34
1893	7,	Full bloom	1,224	10.44	2.66	43.13	36.06	7.71
1894	7,	Seed forming	1,353	6.89	2.72	45.89	37.13	7.37
1896	7,	Seed forming	1,661	10.07	3.90	49.29	28.20	8.54
1897	7,	Late bloom	1,857	7.85	2.89	46.69	35.40	7.17
1898	7,	Late bloom	1,977	7.03	3.01	50.30	32.58	7.08
	Average,		.....	8.30	3.03	47.85	33.45	7.37
	<i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Nitr. of soda, 480 lbs. (nitrogen, 75 lbs.)</i>							
1891	Plot 9,	Seed forming	1,010	10.94	2.89	50.65	28.67	6.85
1893	9,	Full bloom	1,225	14.11	3.25	41.02	33.29	8.33
1894	9,	Seed forming	1,354	9.60	3.13	39.65	39.07	8.55
1896	9,	Seed forming	1,666	12.59	4.94	44.17	30.29	8.01
1897	9,	Late bloom	1,858	11.89	3.69	42.97	33.59	7.86
1898	9,	Late bloom	1,978	11.78	4.14	45.30	30.28	8.50
	Average,		.....	11.82	3.67	43.96	32.53	8.02
	TALL RED TOP. (AGROSTIS VULGARIS MAJOR.)							
	<i>Nothing.</i>							
1896	Plot 0,	Seed forming	1,653	6.70	3.23	53.19	29.60	7.28
1897	0,	Seed forming	1,860	7.08	3.21	51.79	31.32	6.60
	Average,			6.89	3.22	52.49	30.46	6.94

TABLE 35.—CONTINUED.

Year.	Plot No. and kind and amount of fertilizer per acre.	Condition of growth when harvested.	Laboratory No.	PERCENTAGE COMPOSITION OF DIFFERENT SPECIES OF GRASSES CALCULATED ON WATER-FREE SUBSTANCE.				
				Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
	<i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Nitrogen, —</i>			Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
1896	Plot 6, . . .	Seed forming	1,658	6.62	3.30	53.32	30.34	6.42
1897	6, . . .	Seed forming	1,859	6.58	3.29	50.97	31.78	7.38
	Average,		.....	6.60	3.30	52.14	31.06	6.90
	<i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Nitr. of soda, 160 lbs. (nitrogen, 25 lbs.)</i>							
1891	Plot 7, . . .	Full bloom	1,021	8.81	3.03	51.47	28.76	7.93
1892	7, . . .	Full bloom	1,064	7.56	2.79	49.73	32.75	7.17
1896	7, . . .	Seed forming	1,663	8.20	3.74	52.42	28.76	6.88
1897	7, . . .	Seed forming	1,861	6.33	3.04	54.95	29.99	5.69
	Average,		.....	7.73	3.15	52.14	30.06	6.92
	<i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Nitr. of soda, 480 lbs. (nitrogen, 75 lbs.)</i>							
1891	Plot 9, . . .	Full bloom	1,027	13.31	3.36	48.16	26.87	8.30
1892	9, . . .	Full bloom	1,065	9.31	3.16	48.87	31.88	6.78
1896	9, . . .	Seed forming	1,668	9.86	3.50	52.11	28.39	6.14
1897	9, . . .	Seed forming	1,862	9.13	2.92	52.23	30.19	5.53
	Average,		.....	10.40	3.24	50.34	29.33	6.69
	BROME GRASS. (BROMUS INERMIS.)							
	<i>Nothing.</i>							
1896	Plot 0, . . .	Seed forming	1,652	8.02	3.48	52.06	28.84	7.60
1898	0, . . .	Late bloom	1,967	8.24	3.24	49.05	31.94	7.53
	Average,		.....	8.13	3.36	50.55	30.39	7.57
	<i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Nitrogen, —</i>							
1896	Plot 6, . . .	Seed forming	1,657	8.09	3.38	51.70	27.83	9.00
1898	6, . . .	Late bloom	1,968	8.24	3.31	49.35	30.86	8.24
	Average,		.....	8.17	3.35	50.52	29.34	8.62
	<i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Nitr. of soda, 160 lbs. (nitrogen, 25 lbs.)</i>							
1896	Plot 7, . . .	Seed forming	1,662	9.39	3.51	50.82	28.52	7.76
1898	7, . . .	Late bloom	1,969	8.05	3.27	49.51	31.94	7.23
	Average,			8.72	3.39	50.16	30.23	7.50

TABLE 35.—CONTINUED.

Year.	Plot No. and kind and amount of fertilizer per acre.	Condition of growth when harvested.	Laboratory No.	PERCENTAGE COMPOSITION OF DIFFERENT SPECIES OF GRASSES CALCULATED ON WATER-FREE SUBSTANCE.				
				Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
				Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
1896	<i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Nitr. of soda, 480 lbs. (nitrogen, 75 lbs.)</i>	Seed forming	1,667	13.38	4.25	44.71	30.33	7.33
1898	Plot 9,	Late bloom	1,970	12.56	3.87	43.16	32.74	7.67
	Average,		.....	12.97	4.06	43.93	31.54	7.50
TALL MEADOW OAT GRASS. (<i>AVENÆ ELATIOR.</i>)								
	<i>Nothing.</i>							
1893	Plot 0,	Seed forming	1,218	7.68	3.13	47.11	35.02	7.06
1894	0,	Seed forming	1,347	7.98	3.02	45.04	36.71	7.25
	Average,		.....	7.83	3.08	46.07	35.87	7.15
	<i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Nitrogen, —</i>							
1893	Plot 6,	Seed forming	1,219	7.42	3.12	45.90	36.17	7.39
1894	6,	Seed forming	1,348	7.57	3.17	44.08	37.44	7.74
	Average,		.....	7.50	3.14	44.99	36.80	7.57
	<i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Nitr. of soda, 160 lbs. (nitrogen, 25 lbs.)</i>							
1892	Plot 7,	Seed forming	1,048	10.50	3.06	44.88	34.07	7.49
1893	7,	Seed forming	1,220	10.72	3.53	44.23	34.45	7.07
1894	7,	Seed forming	1,349	8.68	3.19	45.55	35.91	6.67
	Average,		.....	9.97	3.26	44.88	34.81	7.08
	<i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Nitr. of soda, 480 lbs. (nitrogen, 75 lbs.)</i>							
1892	Plot 9,	Seed forming	1,049	11.94	3.31	43.97	33.28	7.50
1893	9,	Seed forming	1,221	13.74	3.64	42.80	32.46	7.36
1894	9,	Seed forming	1,350	11.52	3.39	42.56	35.70	6.83
	Average,		.....	12.40	3.45	43.11	33.81	7.23
FOWL MEADOW GRASS. (<i>POA SEROTINA.</i>)								
	<i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Nitr. of soda, 160 lbs. (nitrogen, 25 lbs.)</i>							
1891	Plot 7,	Full bloom	1,012	12.06	3.28	42.30	32.84	9.52

TABLE 35.—CONTINUED.

Year.	Plot No. and kind and amount of fertilizer per acre.	Condition of growth when harvested.	Laboratory No.	PERCENTAGE COMPOSITION OF DIFFERENT SPECIES OF GRASSES CALCULATED ON WATER-FREE SUBSTANCE.				
				Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
1891	<i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Nitr. of soda, 480 lbs. (nitrogen, 75 lbs.)</i> Plot 9,	Full bloom	1,013	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
				14.87	2.83	42.25	31.65	8.40
1892	KENTUCKY BLUE GRASS. (POA PRATENSIS.) <i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Nitr. of soda, 160 lbs. (nitrogen, 25 lbs.)</i> Plot 7,	Seed forming	1,050	12.88	4.04	44.89	31.49	6.70
1892	<i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Nitr. of soda, 480 lbs. (nitrogen, 75 lbs.)</i> Plot 9,	Seed forming	1,051	15.44	4.51	43.49	29.62	6.94
1891	ENGLISH RYE GRASS. (LOLIUM PERENNE.) <i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Nitr. of soda, 160 lbs. (nitrogen, 25 lbs.)</i> Plot 7,	Late bloom	1,008	12.62	2.92	48.69	27.71	8.06
1891	<i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Nitr. of soda, 480 lbs. (nitrogen, 75 lbs.)</i> Plot 9,	Late bloom	1,009	10.87	2.71	50.79	27.54	8.09

Explanation of tables 36 and 37. — Table 36 gives the composition of samples of cow pea fodder grown in the special nitrogen experiments. These experiments include two plots with no fertilizer, two plots with mineral fertilizer only (phosphoric acid and potash), three plots with nitrate of soda and mineral fertilizer, and three plots with sulphate of ammonia and minerals. A few analyses of samples from a single soil test experiment were added, two from nothing plots, one from a mineral plot (F), and one from a plot (G) with the first nitrogen ration (25 pounds per acre). The cow peas were grown for green feed, or for silage, and the crop was harvested before many pods had formed — if any were present they were sampled with the fodder. The kinds and amounts of fertilizing materials and the quantities of nitrogen used on different plots are shown in the second column, and the kind of experiment in the third; the balance of the table shows the percentages of the various food constituents on the basis of water-free substance. The average composition of the crops from the different plots is shown in bold-faced type, which figures are used in the summary Table 20 on page 150 of the text of this article.

Table 37 gives the yield per acre of the water-free substance and of the various food constituents from different plots. The yields of water-free substance were calculated from the weight of the crop, and the percentages of water-free substance in the crop at the time of harvesting. The yields of protein, fat, etc., were obtained by multiplying the weights of water-free substance per acre in Table 37 by the percentages of protein, fat, etc., for the same plots in Table 36. The average yields given in bold face type in Table 37 are used in the summary Table 22, on page 153 of the text.

TABLE 36.—*Effects of nitrogenous fertilizers upon cow pea fodder.*

[The details of the analyses may be found in the Reports of the Station for the years in which the several experiments were made or for the succeeding year.]

Year.	Plot No. and kind and amount of fertilizer per acre.	Kind of experiment.	Laboratory No.	PERCENTAGE COMPOSITION OF COW PEA FODDER CALCULATED ON WATER-FREE SUBSTANCE.				
				Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
				Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
1893	<i>Nothing.</i>							
1893	Plot o,	Soil test	1,234	17.11	3.76	47.50	19.95	11.68
1893	oo,	"	1,235	19.21	3.69	44.03	20.06	13.01
1893	ooo,	"	1,236	18.83	3.07	44.17	21.02	12.91
1893	o,	"	1,246	21.73	4.17	38.50	21.92	13.68
1895	o,	Spe. nitrogen	1,485	17.84	3.82	48.18	20.43	9.73
1895	oo,	"	1,486	15.05	3.77	49.62	22.15	9.41
1896	o,	"	1,718	16.82	2.92	42.99	25.23	12.04
1896	oo,	"	1,719	20.03	3.91	44.95	18.96	12.15
1897	o,	"	1,872	21.69	4.14	37.37	23.35	13.45
1897	oo,	"	1,880	18.13	3.03	44.02	23.46	11.36
1898	o,	"	6,002	16.26	3.17	48.52	22.99	9.06
1898	oo,	"	6,003	17.87	3.40	46.18	21.64	10.91
	Average,		.....	18.38	3.57	44.67	21.76	11.62
	<i>Dis. boneblack, 320 lbs.</i>							
	<i>Mur. of potash, 160 lbs.</i>							
	<i>Nitrogen,—</i>							
1893	Plot F,	Soil test	1,242	19.88	3.61	41.06	22.53	12.92
1894	6,	Spe. nitrogen	1,366	18.81	3.84	41.09	23.38	12.88
1895	6a,	"	1,487	16.73	3.47	45.31	24.87	9.62
1895	6b,	"	1,488	15.40	3.27	50.85	21.37	9.11
1896	6a,	"	1,720	19.66	3.59	41.40	22.55	12.80
1896	6b,	"	1,721	18.23	2.87	44.84	22.48	11.58
1897	6a,	"	1,871	19.25	3.12	44.77	22.24	10.62
1897	6b,	"	1,876	18.17	2.49	43.33	25.37	10.64
1898	6a,	"	6,004	17.98	2.91	45.50	24.50	9.11
1898	6b,	"	6,005	19.57	2.66	41.97	25.45	10.35
	Average,		.....	18.37	3.18	44.01	23.48	10.96
	<i>Dis. boneblack, 320 lbs.</i>							
	<i>Mur. of potash, 160 lbs.</i>							
	<i>Nitr. of soda, 160 lbs. (ni-</i>							
	<i>trogen, 25 lbs.)</i>							
1893	Plot G,	Soil test	1,243	18.02	3.58	42.65	22.24	13.51
1893	7,	Spe. nitrogen	1,247	21.06	4.11	37.88	23.06	13.89
1894	7,	"	1,367	17.81	4.28	44.49	29.85	12.47
1895	7,	"	1,489	17.57	3.21	46.54	23.69	8.99
1896	7,	"	1,722	16.81	2.98	46.15	22.97	11.09
1897	7,	"	1,879	17.68	2.86	43.82	25.38	10.26
1898	7,	"	6,006	16.38	2.85	48.35	24.49	7.93
	Average,		.....	17.90	3.41	44.27	23.25	11.17
	<i>Dis. boneblack, 320 lbs.</i>							
	<i>Mur. of potash, 160 lbs.</i>							
	<i>Nitr. of soda, 320 lbs. (ni-</i>							
	<i>trogen, 50 lbs.)</i>							
1895	Plot 8,	Spe. nitrogen	1,490	17.94	3.53	44.85	24.95	8.73
1896	8,	"	1,723	18.90	2.88	43.44	22.67	12.11
1897	8,	"	1,878	19.03	2.64	45.33	22.87	10.13
1898	8,	"	6,007	16.91	3.41	45.66	25.94	8.08
	Average,		.....	18.20	3.11	44.82	24.11	9.76

TABLE 36.—CONTINUED.

Year.	Plot No. and kind and amount of fertilizer per acre.	Kind of experiment.	Laboratory No.	PERCENTAGE COMPOSITION OF COW PEA FODDER CALCULATED ON WATER-FREE SUBSTANCE.				
				Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
	<i>Dis. boneblack, 320 lbs. Mur. of potash, 160 lbs. Nitr. of soda, 480 lbs. (nitrogen, 75 lbs.)</i>			Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
1893	Plot 9,	Spe. nitrogen	1,248	20.02	4.63	40.44	23.06	11.85
1894	9,	"	1,368	20.05	4.04	42.88	20.28	12.75
1895	9,	"	1,491	18.28	3.81	47.38	21.39	9.14
1896	9,	"	1,731	19.49	3.76	44.72	20.41	11.62
1897	9,	"	1,877	18.43	2.55	43.72	24.95	10.35
1898	9,	"	6,008	17.51	3.53	48.15	22.57	8.24
	Average,		.....	18.96	3.72	44.55	22.11	10.66
	<i>Dis. boneblack, 320 lbs. Mur. of potash, 160 lbs. Sul. of Amm., 120 lbs. (nitrogen, 25 lbs.)</i>							
1895	Plot 10,	Spe. nitrogen	1,492	18.39	3.74	46.63	21.05	10.19
1896	10,	"	1,724	19.02	3.07	41.67	24.39	11.85
1897	10,	"	1,875	18.43	2.99	43.13	23.94	11.51
1898	10,	"	6,009	16.82	3.16	45.26	25.15	9.61
	Average,		.....	18.17	3.24	44.17	23.63	10.79
	<i>Dis. boneblack, 320 lbs. Mur. of potash, 160 lbs. Sul. of Amm., 240 lbs. (nitrogen, 50 lbs.)</i>							
1895	Plot 11,	Spe. nitrogen	1,493	18.20	4.21	46.78	20.17	10.64
1896	11,	"	1,725	16.61	2.71	46.10	23.70	10.88
1897	11,	"	1,874	15.91	3.63	47.08	22.49	10.89
1898	11,	"	6,010	17.99	2.60	44.10	25.25	10.06
	Average,		.....	17.18	3.29	46.01	22.90	10.62
	<i>Dis. boneblack, 320 lbs. Mur. of potash, 160 lbs. Sul. of Amm., 360 lbs. (nitrogen, 75 lbs.)</i>							
1895	Plot 12,	Spe. nitrogen	1,494	16.09	3.43	49.58	20.88	10.02
1896	12,	"	1,726	21.39	2.63	38.43	24.25	13.30
1897	12,	"	1,873	22.79	3.37	39.35	23.34	11.15
1898	12,	"	6,011	17.03	2.77	46.54	23.39	10.27
	Average,		.....	19.32	3.05	43.48	22.96	11.19

TABLE 37.—*Effects of nitrogenous fertilizers upon cow pea fodder.*

[The details of the experiments may be found in the Reports of the Station for the years in which the several experiments were made or for the year following.]

Year.	Plot No. and kind and amount of fertilizer per acre.	Kind of experiment.	YIELD OF DRY MATTER AND NUTRIENTS IN COW PEA FODDER PER ACRE.					
			Water free substance.	Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
	<i>Nothing.</i>		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1895	Plots 0, 00, . .	Spe. nitrogen	2,115	348	80	1,035	450	202
1896	0, 00, . .	"	2,111	390	72	927	467	255
1897	0, 00, . .	"	1,519	302	54	618	356	189
1898	0, 00, . .	"	1,985	339	65	940	443	198
	Average,		1,932	344	68	880	429	211
	<i>Dis. boneblack, 320 lbs.</i>							
	<i>Mur. of potash, 160 lbs.</i>							
	<i>Nitrogen. —</i>							
1895	Plots 6a, 6b, . .	Spe. nitrogen	4,299	691	145	2,066	994	403
1896	6a, 6b, . .	"	3,510	665	113	1,515	790	427
1897	6a, 6b, . .	"	3,236	605	91	1,425	771	341
1898	6a, 6b, . .	"	3,743	703	104	1,637	935	364
	Average,		3,697	666	113	1,661	873	384
	<i>Dis. boneblack, 320 lbs.</i>							
	<i>Mur. of potash, 160 lbs.</i>							
	<i>Nitrogen (diff. forms), 25 lbs.</i>							
1895	Plots 7, 10, . .	Spe. nitrogen	4,108	739	143	1,913	919	394
1896	7, 10, . .	"	3,861	645	110	1,781	901	424
1897	7, 10, . .	"	3,249	583	95	1,413	804	354
1898	7, 10, . .	"	4,195	696	126	1,964	1,041	368
	Average,		3,853	666	118	1,768	916	385
	<i>Dis. boneblack, 320 lbs.</i>							
	<i>Mur. of potash, 160 lbs.</i>							
	<i>Nitrogen (diff. forms), 50 lbs.</i>							
1895	Plots 8, 11, . .	Spe. nitrogen	3,949	714	153	1,808	891	383
1896	8, 11, . .	"	3,753	756	104	1,536	880	477
1897	8, 11, . .	"	3,146	548	98	1,454	715	331
1898	8, 11, . .	"	3,923	684	118	1,760	1,004	356
	Average,		3,693	665	118	1,640	873	387
	<i>Dis. boneblack, 320 lbs.</i>							
	<i>Mur. of potash, 160 lbs.</i>							
	<i>Nitrogen (diff. forms), 75 lbs.</i>							
1895	Plots 9, 12, . .	Spe. nitrogen	4,016	690	145	1,947	849	385
1896	9, 12, . .	"	3,547	683	121	1,532	795	416
1897	9, 12, . .	"	2,812	578	83	1,168	681	302
1898	9, 12, . .	"	4,107	709	129	1,945	944	380
	Average,		3,620	665	119	1,648	817	371

Explanation of Tables 38 and 39. — Table 38 gives analyses of samples of soy bean seeds from a series of special nitrogen experiments similar to those carried on with cow pea fodder. These experiments include two plots without fertilizer, two plots with mineral fertilizer (phosphoric acid and potash) only, three plots with nitrate of soda and mineral fertilizers, and three plots with sulphate of ammonia and mineral fertilizers. The analyses include only samples of the seed, as the vines dropped their leaves almost entirely before the seed was fully ripe, making it impracticable to sample the straw. The table shows the kinds and amounts of fertilizing materials and the quantities of nitrogen used, the kind of experiment, and the percentages of the various food constituents on the basis of water-free substance. The average composition of the crops from plots having the same kinds and amounts of fertilizers is shown in bold face type, which figures are used in the summary Table 21 on page 150 of the text.

Table 39 gives the yields per acre of water-free substance, and of the various food constituents. The yields of water-free substance were calculated from the total weights of the seed when the crop was threshed, and the proportion of water-free material found in the samples of the seeds at that time. The yields of food constituents were obtained by multiplying the weights of the water-free substance as shown in Table 39 by the percentages of the various food constituents as shown in Table 38. The average yields per acre of crops grown under similar conditions are given here in Table 39 in bold face, which figures are used in the summary Table 23 on page 153 in the text of the article.

TABLE 38.—*Effects of nitrogenous fertilizers upon soy beans (seeds).*

[The details of the analyses may be found in the Reports of the Station for the years in which the several experiments were made or for the succeeding year.]

Year.	Plot No. and kind and amount of fertilizer per acre.	Kind of experiment.	Laboratory No.	PERCENTAGE COMPOSITION OF SOY BEANS CALCULATED ON WATER-FREE SUBSTANCE.				
				Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
				Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
	<i>Nothing.</i>							
1895	Plot o,	Spe. nitrogen	1,577	35.17	19.81	28.18	3.23	13.61
1895	oo,	"	1,578	39.31	20.17	27.90	3.27	9.35
1897	o,	"	1,836	38.14	18.16	30.07	8.75	4.88
1897	oo,	"	1,837	37.27	16.81	37.20	4.14	4.58
1898	o,	"	6,012	44.21	19.21	27.15	4.00	5.43
1898	oo,	"	6,013	45.65	19.86	25.43	3.62	5.44
	Average,			39.96	19.00	29.32	4.50	7.22
	<i>Dis. boneblack, 320 lbs. Mur. of potash, 160 lbs. Nitrogen, —</i>							
1894	Plot 6,	Spe. nitrogen	1,363	40.20	18.10	30.62	4.98	6.10
1895	6a,	"	1,579	35.10	22.37	31.96	3.37	7.20
1895	6b,	"	1,580	38.05	21.34	30.57	3.52	6.52
1897	6a,	"	1,838	38.32	17.88	34.07	4.38	5.35
1897	6b,	"	1,839	38.55	17.66	33.86	4.52	5.41
1898	6a,	"	6,014	42.23	21.16	27.46	3.42	5.73
1898	6b,	"	6,015	42.64	21.54	26.88	3.25	5.60
	Average,			39.30	20.01	30.77	3.92	6.00
	<i>Dis. boneblack, 320 lbs. Mur. of potash, 160 lbs. Nitrate of soda, 160 lbs. (nitrogen, 25 lbs.)</i>							
1894	Plot 7,	Spe. nitrogen	1,364	40.05	18.07	30.99	5.41	5.48
1895	7,	"	1,581	36.95	21.71	30.53	3.25	7.56
1897	7,	"	1,840	37.58	18.13	34.33	4.64	5.32
1898	7,	"	6,016	44.91	21.10	25.67	2.45	5.67
	Average,			39.87	19.75	30.43	3.94	6.01
	<i>Dis. boneblack, 320 lbs. Mur. of potash, 160 lbs. Nitrate of soda, 320 lbs. (nitrogen, 50 lbs.)</i>							
1895	Plot 8,	Spe. nitrogen	1,582	39.29	21.44	29.90	3.26	6.11
1897	8,	"	1,841	38.00	18.25	31.07	6.80	5.88
1898	8,	"	6,017	44.77	20.31	26.88	2.55	5.49
	Average,			40.69	20.00	29.28	4.20	5.83
	<i>Dis. boneblack, 320 lbs. Mur. of potash, 160 lbs. Nitrate of soda, 480 lbs. (nitrogen, 75 lbs.)</i>							
1894	Plot 9,	Spe. nitrogen	1,365	42.53	18.16	29.43	4.53	5.35
1895	9,	"	1,583	41.40	20.43	28.65	3.40	6.12
1897	9,	"	1,842	38.09	18.95	32.98	4.61	5.37
1898	9,	"	6,018	44.40	20.72	26.33	2.94	5.61
	Average,			41.61	19.56	29.35	3.87	5.61

TABLE 38. — CONTINUED.

Year.	Plot No. and kind and amount of fertilizer per acre.	Kind of experiment.	Laboratory No.	PERCENTAGE COMPOSITION OF SOY BEANS CALCULATED ON WATER-FREE SUBSTANCE.				
				Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
	<i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Sul. of ammonia, 120 lbs.</i> <i>(nitrogen, 25 lbs.)</i>			Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
1895	Plot 10,	Spe. nitrogen	1,584	36.86	21.97	30.95	3.58	6.64
1897	10,	"	1,843	41.45	18.41	30.31	4.58	5.25
1898	10,	"	6,019	41.64	21.40	28.03	3.48	5.45
	Average,			39.99	20.59	29.76	3.88	5.78
	<i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Sul. of ammonia, 240 lbs.</i> <i>(nitrogen, 50 lbs.)</i>							
1895	Plot 11,	Spe. nitrogen	1,585	37.71	21.58	31.40	3.38	5.93
1897	11,	"	1,844	41.93	18.22	30.15	4.47	5.23
1898	11,	"	6,020	42.54	21.82	27.15	2.87	5.62
	Average,			40.73	20.54	29.57	3.57	5.59
	<i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Sul. of ammonia, 360 lbs.</i> <i>(nitrogen, 75 lbs.)</i>							
1895	Plot 12,	Spe. nitrogen	1,586	39.82	20.71	29.08	3.49	6.90
1897	12,	"	1,845	42.12	18.00	29.33	4.73	5.82
1898	12,	"	6,021	42.05	21.77	26.72	3.38	6.08
	Average,			41.33	20.16	28.38	3.87	6.26

TABLE 39.—*Effects of nitrogenous fertilizers upon soy beans (seeds).*

[The details of the experiments may be found in the Reports of the Station for the years in which the several experiments were made or for the year following.]

Year.	Plot No. and kind and amount of fertilizer per acre.	Kind of experiment.	YIELD OF DRY MATTER AND NUTRIENTS IN SOY BEANS PER ACRE.					
			Water free substance.	Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.
	<i>Nothing.</i>		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
1895	Plots 0, 00, . .	Spe. nitrogen	581	216	116	163	19	67
1897	0, 00, . .	"	206	78	36	69	13	10
1898	0, 00, . .	"	449	202	88	118	17	24
	Average,		412	165	80	117	16	34
	<i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Nitrogen, —</i>							
1895	Plots 6a, 6b, . .	Spe. nitrogen	721	264	158	225	25	49
1897	6a, 6b, . .	"	314	121	56	106	14	17
1898	6a, 6b, . .	"	800	339	171	217	27	46
	Average,		612	241	128	183	22	38
	<i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Nitrogen (diff. forms), 25 lbs.</i>							
1895	Plots 7, 10, . .	Spe. nitrogen	760	281	166	233	26	54
1897	7, 10, . .	"	390	155	71	125	18	21
1898	7, 10, . .	"	727	321	154	196	22	40
	Average,		626	252	130	184	22	38
	<i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Nitrogen (diff. forms), 50 lbs.</i>							
1895	Plots 8, 11, . .	Spe. nitrogen	900	347	194	275	30	54
1897	8, 11, . .	"	353	140	64	109	20	20
1898	8, 11, . .	"	866	378	182	234	23	48
	Average,		706	288	147	206	24	41
	<i>Dis. boneblack, 320 lbs.</i> <i>Mur. of potash, 160 lbs.</i> <i>Nitrogen (diff. forms), 75 lbs.</i>							
1895	Plots 9, 12, . .	Spe. nitrogen	921	374	189	266	32	60
1897	9, 12, . .	"	414	166	77	129	19	23
1898	9, 12, . .	"	811	351	182	215	26	47
	Average,		715	297	146	203	26	43

A discussion of the experiments and analyses here detailed is given on pages 113 to 154, and the results and conclusions are summarized on pages 155 to 159.

DIGESTION EXPERIMENTS WITH SHEEP.

BY C. S. PHELPS.

In estimating the values of different feeding stuffs, by chemical analysis as well as in connection with feeding experiments conducted by the Station, very useful information is gained by testing the actual digestibility of the materials. Only that part of the food which the animal can digest is of value for purposes of nutrition. We need to know, therefore, not only the chemical composition of a fodder article, but also the proportions of the various nutrients which are digested, in order to judge of its nutritive value. From experiments made elsewhere, it has been found that all animals of the same class, such as ruminants, digest their food in practically the same way, and that the digestibility of a given feeding stuff by sheep may be taken as a nearly accurate measure of the digestibility of the same fodder by a cow or steer. As the care and labor required in digestion experiments with sheep is much less than with larger animals, sheep have been used in the digestion experiments here reported.

The method of conducting these experiments is described in the Annual Report of the Station for 1894, pages 107-109. For the present purpose the following brief summary will suffice.

The sheep were kept in pens about five feet square, with mangers arranged so as to prevent loss of food by scattering. Each experiment lasted twelve days. The first seven days were devoted to preliminary feeding, during which the feces were not collected and each animal had the run of the pen. At the end of this period the sheep were placed in narrow stalls, where they remained during the five days of the digestion experiment proper, during which the feces were collected in rubber lined bags.

The feeding stuffs, the uneaten residues, and the feces were each weighed and analyzed. The differences between the amounts of organic matter and nutrients in the food eaten and the amounts of the same ingredients in the feces were taken as the measure of the amounts digested. The metabolic products in the feces are here treated as part of the undigested residue of the food.

In previous reports the distinction between " heats of combustion " and " fuel values " has not been explained as clearly as seems desirable. As the terms are here used the heat of combustion of a given food material is the total energy of that material as determined by burning a given amount of it with oxygen in the bomb calorimeter; while the fuel value of the same material is the energy which can become available to the body when the material is eaten. That is to say, the fuel value is the total heat of combustion of the food less that of the corresponding feces and urine.

In the experiments here reported the heats of combustion of the food and of the feces were determined by the bomb calorimeter, and that of the urine was estimated; the difference between the first and the sum of the last two was taken as the measure of the energy of the food digested, *i. e.*, the fuel value of the food eaten.*

The nitrogenous matter of the digested food is not completely oxidized in the body, but a portion is eliminated in the urine as urea and kindred compounds. The potential energy of these compounds is not available to the body, and is deducted from the energy of the material digested to give the amount of energy available from any given material. The amount of energy in the compounds in urine is roughly calculated in the manner described on page 178 of the Annual Report of this Station for 1896, in the discussion of digestion experiments with men. The assumptions made there give results that are probably rather too low. Late research seems to indicate that a larger factor should be assigned to the fuel value of the nitrogenous matter of the urine.

General conclusions from these experiments will hardly be permissible until more data are available. One point, however, is brought out very clearly. Among the feeding stuffs tested those rich in protein, such as the legumes, are more digestible than those with little protein, such as corn fodder, oat fodder, millet, and the like.

Table 40, which follows, gives a summary of the results of the digestion experiments thus far made with sheep by the Station. These experiments are arranged, according to the character of the feeding stuffs used, under the headings: Milling products (with hay), cured fodders and hays, and green fodders and grasses.

* See Report of the Station for 1897, pages 155, 156.

TABLE 40.—*Coefficients of digestibility of nutrients in different feeding stuffs and groups of feeding stuffs as determined by experiments with sheep.*

FEEDING STUFFS.	No. of experiments.	Protein, Nt. $\times 6.25$	Fat.	Nitrogen free extract.	Fiber.	Organic matter.	Energy.
<i>Milling products (with hay).</i>		Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
Bran, corn meal, and hay, { Min.	4	48.0	60.6	71.5	45.6	62.7	57.6
{ Max.	4	62.1	72.0	80.1	60.7	72.8	67.9
{ Avg.	4	55.0	68.5	76.4	55.3	69.0	64.3
Bran, corn meal, linseed meal, { Min.	4	71.2	64.7	73.6	59.0	70.1	63.6
oat and pea meal, and hay, { Max.	4	77.1	73.4	77.0	69.2	75.0	70.3
{ Avg.	4	73.4	70.5	74.8	62.5	71.6	66.0
Soy bean meal and timothy hay, { Min.	8	75.8	71.1	60.9	55.8	65.4	61.3
{ Max.	8	80.0	77.4	71.8	69.5	73.7	68.7
{ Avg.	8	77.7	73.6	66.1	61.3	69.1	64.3
Coarse bran and rowen hay, { Min.	4	67.5	54.9	65.2	44.7	62.0	57.0
mixed grasses, { Max.	4	71.5	66.0	69.4	56.4	67.1	62.4
{ Avg.	4	69.6	60.9	67.2	49.0	63.7	58.6
No. 2 wheat middlings and { Min.	4	70.6	68.9	71.0	54.3	68.5	63.7
rowen hay, mixed grasses, { Max.	4	76.1	71.7	73.0	58.6	69.2	64.4
{ Avg.	4	72.9	70.7	71.8	55.5	68.9	64.0
Fine rowen and Cleveland flax { Min.	3	76.8	49.4	56.1	68.7	65.4	56.5
meal, { Max.	3	81.5	55.9	63.6	70.1	70.2	61.1
{ Avg.	3	78.8	53.4	60.4	69.6	67.9	59.0
Fine rowen and Quaker oat { Min.	3	66.7	38.8	61.3	54.1	60.1	57.2
feed, { Max.	3	71.0	68.8	65.6	58.3	63.3	59.8
{ Avg.	3	68.5	56.3	62.8	55.6	61.3	58.4
Experiments with soy bean meal and timothy hay calculated for digestibility of soy bean meal alone, . .	..	85.8	84.9	73.4	....	78.0	72.5
Experiments with coarse bran and rowen hay of mixed grasses calculated for digestibility of coarse bran alone, . . . . .	..	70.3	72.2	67.2	16.2	61.3	56.6
Experiments with No. 2 wheat middlings and rowen hay of mixed grasses calculated for digestibility of wheat middlings alone, . . . . .	..	75.7	88.8	75.6	30.2	71.3	67.3
Experiments with Cleveland flax meal and fine rowen calculated for digestibility of Cleveland flax meal alone, . .	..	85.4	83.1	57.0	92.8	76.1	61.0
Experiments with Quaker oat feed and fine rowen calculated for digestibility of oat feed alone, . . . . .	..	62.8	54.8	42.6	67.2	52.4	52.7
<i>Cured fodders and hays.</i>							
Rowen hay, mixed grasses chiefly Kentucky blue grass, { Min.	4	67.6	44.0	62.6	65.4	63.5	57.1
{ Max.	4	70.2	50.5	67.7	68.2	66.7	60.9
{ Avg.	4	69.1	46.2	65.1	66.5	65.2	58.9
Rowen hay, mostly timothy, { Min.	4	66.1	48.2	60.9	62.0	62.0	58.3
{ Max.	4	69.4	50.8	64.9	73.4	67.2	60.9
{ Avg.	4	68.0	49.5	63.4	66.5	64.4	59.3
Rowen hay, mixed grasses, { Min.	8	67.7	43.9	60.4	62.5	62.7	56.8
{ Max.	8	73.7	50.6	68.5	72.4	68.1	62.4
{ Avg.	8	70.8	46.9	64.8	66.2	65.5	59.5
Rowen hay, clover, field cured, { Min.	2	60.3	58.3	63.1	47.6	58.1	53.0
{ Max.	2	65.1	60.4	64.1	50.7	60.5	54.5
{ Avg.	2	62.7	59.4	63.6	49.2	59.3	53.8

TABLE 40.—CONTINUED.

FEEDING STUFFS.	No. of experi- ments.	Protein, N $\times \frac{6.25}{100}$.	Fat.	Nitrogen free extract.	Fiber.	Organic matter.	Energy.
		Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
<i>Cured fodders and hays.</i>							
Rowen hay, clover, barn cured,	Min.	2	64.7	59.9	61.7	44.7	58.0
	Max.	2	69.1	60.5	62.2	46.4	59.7
	Avg.	2	66.9	60.2	62.0	45.6	58.9
Scarlet clover hay, field cured,	Min.	4	67.8	45.9	57.3	39.8	52.9
	Max.	4	68.9	52.4	62.7	47.3	56.6
	Avg.	4	68.3	49.2	60.0	43.7	54.8
Scarlet clover hay, barn cured,	Min.	3	67.2	29.5	59.8	42.8	56.2
	Max.	3	73.2	42.3	63.9	48.9	57.8
	Avg.	3	69.3	34.9	61.8	46.2	57.2
Oat hay (early seed),	Min.	4	52.3	60.5	50.5	39.4	47.9
	Max.	4	57.7	63.0	53.9	46.8	52.6
	Avg.	4	54.2	61.9	52.0	43.5	50.1
<i>Green fodders and grasses.</i>							
Scarlet clover fodder,	Min.	3	76.7	62.9	74.1	54.1	68.5
	Max.	3	77.5	69.3	74.9	57.9	69.8
	Avg.	3	77.1	66.5	74.5	56.1	69.1
Barley fodder,	Min.	6	66.7	48.2	69.3	47.2	62.2
	Max.	6	73.1	63.1	76.3	66.4	70.8
	Avg.	6	70.7	56.3	72.2	59.1	67.7
Barley and pea fodder,	Min.	4	73.2	54.5	55.8	37.6	55.2
	Max.	4	81.1	64.8	75.8	61.4	71.3
	Avg.	4	75.9	59.1	68.5	52.4	65.7
Oat and pea fodder,	Min.	7	67.8	54.9	56.2	48.2	57.8
	Max.	7	82.7	74.3	67.1	67.4	70.2
	Avg.	7	76.3	67.0	63.9	55.5	63.9
Oat fodder,	Min.	5	67.8	67.5	60.0	43.5	56.5
	Max.	5	75.7	72.3	66.9	62.6	65.4
	Avg.	5	72.6	69.5	62.8	54.6	61.8
Barnyard millet fodder,	Min.	3	45.0	59.8	64.4	58.8	61.8
	Max.	3	57.3	71.8	68.4	63.2	65.6
	Avg.	3	50.5	67.7	67.0	61.5	64.2
Hungarian fodder,	Min.	4	61.0	59.8	66.3	70.3	67.6
	Max.	4	71.8	85.1	71.7	76.1	73.8
	Avg.	4	65.3	72.3	68.9	72.8	70.1
Soy bean fodder,	Min.	12	67.7	30.7	68.7	38.5	61.0
	Max.	12	80.5	61.5	80.7	55.5	68.7
	Avg.	12	75.5	48.1	75.0	46.1	65.3
Clover rowen,	Min.	2	61.4	60.0	63.9	51.5	59.7
	Max.	2	62.3	61.5	66.7	53.6	61.9
	Avg.	2	61.9	60.8	65.3	52.6	60.8
Rowen, mixed grasses and clover,	Min.	2	64.9	54.0	71.3	61.8	67.0
	Max.	2	69.9	56.3	71.9	63.3	67.8
	Avg.	2	67.4	55.2	71.6	62.6	67.4
Rowen, mostly timothy,	Min.	2	71.5	50.9	67.3	60.0	65.3
	Max.	2	71.9	54.8	68.2	67.6	67.5
	Avg.	2	71.7	52.8	67.8	63.8	66.4
Sweet corn fodder,	Min.	12	52.5	62.4	73.3	53.6	67.5
	Max.	12	68.7	82.1	82.4	72.2	78.8
	Avg.	12	61.6	74.8	76.8	60.2	71.8
Cow pea fodder,	Min.	4	72.7	56.3	76.4	57.1	72.1
	Max.	4	77.3	62.5	84.2	62.4	76.0
	Avg.	4	75.6	59.4	80.6	58.6	74.0
Canada pea fodder,	Min.	2	81.1	50.0	70.8	62.4	71.0
	Max.	2	83.0	54.8	71.3	62.4	71.7
	Avg.	2	82.1	52.4	71.1	62.4	71.4

The details of experiments Nos. 1-9 will be found in the Annual Report for 1894; Nos. 10-27 in the Report for 1895, and Nos. 28-44 in the Report for 1896. The detailed account of experiments 45-55 follows.

DIGESTION EXPERIMENT No. 45.

Sweet corn fodder (fed green).—The description of this experiment was given on page 255, and the results summarized in table 72, page 251 of the Report of 1896. The details are given on page 210 of this report.

DIGESTION EXPERIMENT No. 46.

Oat and pea fodder (fed green).—The experiment began July 15, 1897, and continued 14 days. The feces were collected for the five days from July 24, at 6 P.M. to July 29, at 6 P.M. Two samples were taken, one July 17, the other July 24. In the first sample the oat seed was formed but was quite soft; peas nearly out of bloom. Many pods and seeds were well formed. The bottom leaves of the peas were slightly moldy or dead. In the second sample the oat seeds were somewhat firm and the husks were turning white, while the leaves were more or less rusty. The peas were past bloom and many of the pods were hard. The fodder was badly lodged from a recent storm which prevented taking another sample July 22 as was planned. The first three days each animal, sheep A, B, C, and D, was fed daily 3,000 grams of the fodder, in two feeds of 1,500 grams each; and the remaining eleven days of the experiment, 2,800 grams of the fodder were fed to each animal daily, in two equal portions. Some refuse was left by each animal. Sheep A left very little (none at all after July 24); B and C left so much that they were discarded from the experiment. The refuse left by sheep D was saved from July 17 to the end of the experiment.

DIGESTION EXPERIMENT No. 47.

Soy bean fodder (fed green). The experiment began Aug. 24, 1897, and continued twelve days. The feces were collected for the five days from Aug. 30 at 6 P.M. to Sept. 4 at 6 P.M. The first sample was taken Aug. 28, when the beans were past bloom, with pods well formed and seeds beginning to develop; the stalks were 2½ ft. to 3 ft. high, and the fodder was in excellent condition for feeding. At the time of taking the second sample most of the pods and some seeds were formed. A very few leaves were a trifle rusty or dry, but otherwise the fodder was in good condition for feeding. Each animal, sheep A, B, C, and D, was fed 3,000 grams of the fodder daily, in two equal feeds. The sheep left some refuse which was saved

DIGESTION EXPERIMENT No. 48.

Sweet corn fodder (fed green).—The experiment began Sept. 3, 1897, and continued twelve days. The feces were collected for the five days from Sept. 20 at 5.30 P.M. to Sept. 25 at 6 P.M. The corn was of the "Branching Sweet" variety. Two samples were taken, one Sept. 17, and the other Sept. 20, 1897. At the time the first sample was taken the corn was of good growth, the tassels and silk were nearly dry, the leaves and stalks were a trifle rusty, the ears were well formed and the corn was in the milk stage. The second sample was the same as the first, with the exception that the seeds were slightly hardened and the bottom leaves of the stalks were becoming dry. Each animal, sheep A, B, C, and D, was fed daily 3,000 grams of the fodder in two equal feeds. Each of the four sheep left refuse. That left by sheep C and D was collected and saved, but the amount left by sheep A and B was so large that the animals were discarded from the experiment.

DIGESTION EXPERIMENT No. 49.

Barley and pea fodder (fed green).—The experiment began Oct. 11, 1897, and continued thirteen days. The feces were collected for the five days from Oct. 18 at 5 P.M. to Oct. 23 at 5 P.M. Two samples were taken, one Oct. 15, the other Oct. 19. In the first the barley was of fair growth, the heads and rudiments of seeds were formed and the leaves were more or less rusty or dead. The peas were not yet in bloom, but were in good condition for feeding. In the second the barley was in about the same condition as in the first, except that the heads were grown to the early seed stage. Buds were well formed on the peas, but none were in blossom. During the first four days of the experiment each sheep was fed 3,000 grams of the fodder daily in two equal feeds, and the remaining nine days 2,800 grams of the fodder was fed to each sheep daily in two equal feeds. Both animals left some refuse, but the quantity was so very small that it was left out of account in computing the results.

DIGESTION EXPERIMENT No. 50.

Barley fodder, fed green. The experiment began Oct. 11, 1897, and continued thirteen days. The feces were collected for the five days from Oct. 18 at 5 P.M. to Oct. 23 at 5 P.M. At the time of taking the first, Oct. 15, the barley was in fair growth, with heads well developed and seeds forming. The bottom leaves were either rusty or dead, but otherwise it was in fair condition for feeding. The second sample, taken Oct. 19, was in practically the same condition as the first. Each animal, sheep C and D, was fed 2,800 grams of the fodder daily for the first four days, and for the last nine days 3,000 grams were fed daily in two equal feeds. Both sheep left a small amount of refuse, which was saved, but finally discarded as being too small to take into account.

DIGESTION EXPERIMENT No. 51.

Rowen, mixed grasses, nearly free from clover. The experiment began Dec. 8, 1897, and continued twelve days. The feces were collected for the five days from the evening of Dec. 15 to the evening of Dec. 20. The rowen was sampled Dec. 9, from a lot weighed out for eleven days' rations. Each animal, sheep A, B, C, and D, was fed daily 700 grams of the rowen cut into pieces about one inch long. Sheep A, B, and C ate well during the whole test. Sheep D left about one-fourth of his ration the evening of Dec. 18. During the remainder of the experiment he ate all but a small quantity. The refuse was assumed to be of the same composition as the rowen fed.

DIGESTION EXPERIMENT No. 52.

Cleveland flax-meal with fine rowen. The rowen was the same as was used in experiment No. 51, and was sampled from a 50-pound lot cut into pieces about one inch long. The flax-meal was sampled from an 80-pound lot out of which rations for twelve days were weighed. The experiment began Jan. 31, 1898, and continued twelve days. Each animal, sheep A, B, C, and D, was fed daily 200 grams of the rowen. Sheep A and C were each fed 200 grams and sheep B and D 100 grams of flax-meal daily. Sheep B did not eat the ration well and was discarded from the experiment. The feces were collected for the five days from the evening of Feb. 7 to the evening of Feb. 12.

DIGESTION EXPERIMENT No. 53.

Quaker oat feed with fine rowen. The rowen was the same as was used in experiment No. 51 and was sampled Mar. 2 from a 50-pound lot cut into pieces about one inch long. The Quaker oat feed was from a lot of 90 pounds, and was the same as that used in cow-feeding experiment No. 47. The experiment began Mar. 2, 1898, and continued twelve days. Each animal, sheep A, C, and D, was fed daily 500 grams of rowen and 500 grams of Quaker oat feed. The feces were collected for the five days from the evening of Mar. 9 to the evening of Mar. 14. The experiment was normal throughout.

DIGESTION EXPERIMENT No. 45. SWEET CORN FODDER (FED GREEN).

Composition of feeding stuffs and of feces.

Laboratory No.		Water.	Protein N.×6.25.	Fat.	Nitrogen free extract.	Fiber.	Ash.	Organic matter.	Heat of combustion.*
	<i>Feeding stuff.</i>								
	Sweet corn fodder.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Calories
1,729	Sample 1, .	82.6	1.8	.5	9.9	4.0	1.2	16.2	772
1,730	Sample 2, .	81.0	1.8	.6	10.9	4.5	1.2	17.8	854
	Average,	81.8	1.8	.6	10.4	4.3	1.2	17.0	813
	<i>Feces.</i>								
1,734	Sheep C, . . .	7.2	11.2	2.5	46.3	23.8	9.0	83.8	4,330
1,735	Sheep D, . . .	7.5	11.9	2.3	42.9	28.1	7.3	85.2	4,392

* Per gram as determined.

DIGESTION EXPERIMENTS WITH SHEEP.

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DIGESTION EXPERIMENT No. 45.—CONTINUED.

Weights of food eaten, and of feces for five days, and weights and per cents of nutrients digested.

	Total weight.	Protein N. $\times 6.25$.	Fat.	Nitrogen free extract.	Fiber.	Ash.	Organic matter.
<i>Eaten in 5 days.</i>	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep C and D, fed each,	13,700	247	69	1,425	589	164	2,330
<i>Feces for 5 days.</i>							
Sheep C,	816	91	21	378	194	73	684
Sheep D,	870	104	20	373	244	64	741
<i>Amount digested.</i>							
Sheep C,	12,884	156	48	1,047	395	91	1,646
Sheep D,	12,830	143	49	1,052	345	100	1,589
<i>Per cent. digested.</i>	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Sheep C, . . . . .	.....	63.2	69.6	73.5	67.1	55.5	70.6
Sheep D, . . . . .	.....	57.9	71.0	73.8	58.6	61.0	68.2
Average, . . . . .	.....	60.3	70.3	73.7	62.9	58.3	69.4

Heat of combustion of food for five days, and total available energy.

	HEAT OF COMBUSTION.				Total available energy.	Per cent. available energy.
	Of food eaten.	Of feces.	Of food digested.	Of urine. Estimated.		
	Calories.	Calories.	Calories.	Calories.	Calories.	Per cent.
Sheep C,	11,138	3,533	7,605	136	7,469	67.0
Sheep D,	11,138	3,821	7,317	124	7,193	64.5
Average, . . . . .	.....	.....	.....	.....	.....	65.7

DIGESTION EXPERIMENT No. 46. OAT AND PEA FODDER (FED GREEN).

Composition of feeding stuffs and feces.

Laboratory No.	Water.	Protein. N. $\times 6.25$.	Fat.	Nitrogen free extract.	Fiber.	Ash.	Organic matter.	Heat of combustion.*
<i>Feeding stuff.</i>								
Oats and Peas.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Calories
1,881 Sample 1,	74.4	2.8	1.0	12.0	7.9	1.9	23.7	1,133
1,882 Sample 2,	74.3	3.2	.9	11.7	7.8	2.1	23.6	1,136
Average,	74.4	3.0	.9	11.8	7.9	2.0	23.7	1,134
<i>Feces.</i>								
1,864 Sheep A,	5.8	8.3	3.3	37.4	34.7	10.5	83.7	4,264
1,863 Sheep D,	5.6	7.5	3.4	38.9	34.1	10.5	83.9	4,298
<i>Uneaten residue.</i>								
1,887 Sheep D,	5.8	6.1	4.1	34.3	37.6	12.1	82.1	3,935

* Per gram as determined.

DIGESTION EXPERIMENT NO. 46.—CONTINUED.

Weights of food eaten, and of feces for five days, and weights and per cents. of nutrients digested.

	Total weight.	Protein. N. $\times 6.25$.	Fat.	Nitrogen free extract.	Fiber.	Ash.	Organic matter.
<i>Eaten in 5 days.</i>	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep A and D, fed each,	14,000	420	126	1,652	1,106	280	3,304
Uneaten residue, D, . . .	104	6	4	36	39	13	85
Actually eaten, A, . . .	14,000	420	126	1,652	1,106	280	3,304
Actually eaten, D, . . .	13,896	414	122	1,616	1,067	267	3,219
<i>Feces for 5 days.</i>							
Sheep A,	1,623	135	54	607	563	170	1,359
Sheep D,	1,618	121	55	629	552	170	1,357
<i>Amounts digested.</i>							
Sheep A,	12,377	285	72	1,045	543	110	1,945
Sheep D,	12,278	293	67	987	515	97	1,862
<i>Per cent. digested.</i>		Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
Sheep A,		67.8	57.1	63.3	49.0	39.2	58.9
Sheep D,		70.7	54.9	61.1	48.2	36.3	57.8
Average,		69.2	56.0	62.2	48.6	37.3	58.3

Heat of combustion of food for five days, and total available energy.

	HEATS OF COMBUSTION.				Total available energy.	Per cent. available energy.
	Of food eaten.	Of feces.	Of food digested.	Of urine. Estimated.		
	Calories.	Calories.	Calories.	Calories.	Calories.	Per cent.
Sheep A,	15,876	6,920	8,956	248	8,708	54.9
Sheep D,	15,467	6,954	8,513	255	8,258	53.4
Average, . . . . .	.....	.....	.....	.....	.....	54.1

DIGESTION EXPERIMENT NO. 47. SOY BEAN FODDER (FED GREEN).

Composition of feeding stuffs and feces.

Laboratory No.		Water.	Protein. N. $\times 6.25$.	Fat.	Nitrogen free extract.	Fiber.	Ash.	Organic matter.	Heat of combustion.*
	<i>Feeding stuff.</i>								
	Soy bean fodder.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Calories
1,883	Sample 1, . . .	77.0	3.4	.7	10.4	6.3	2.2	20.8	1,003
1,884	Sample 2, . . .	76.4	3.7	.7	11.0	6.1	2.1	21.5	1,031
	Average,	76.7	3.6	.7	10.7	6.2	2.1	21.2	1,017
	<i>Feces.</i>								
1,865	Sheep A, . . .	3.8	8.4	4.4	21.7	36.9	24.8	71.4	3,800
1,866	Sheep B, . . .	3.8	8.4	4.1	22.2	37.2	24.3	71.9	3,764
1,867	Sheep C, . . .	4.1	9.7	4.8	25.8	34.8	20.8	75.1	3,930
1,868	Sheep D, . . .	3.7	9.4	5.6	25.8	33.1	22.4	73.9	3,947
	<i>Uneaten residue.</i>								
1,888	Sheep B, . . .	5.1	7.0	1.0	31.2	39.8	15.9	79.0	3,714
1,891	Sheep C, . . .	5.0	5.3	.6	33.3	51.3	4.5	90.5	4,216
1,889	Sheep D, . . .	4.8	5.6	.7	33.6	49.0	6.3	88.9	4,162

* Per gram as determined.

Weights of food eaten, and of feces for five days, and weights and per cents of nutrients digested.

	Total weight.	Protein. N. $\times 6.25$.	Fat.	Nitrogen free extract.	Fiber.	Ash.	Organic matter.
<i>Eaten in 5 days.</i>							
Sheep A, B, C, & D, fed each, . . .	Grams. 15,000	Grams. 540	Grams. 105	Grams. 1,605	Grams. 930	Grams. 315	Grams. 3,180
Uneaten residue, B, . . .	44	3	0	14	18	7	35
Uneaten residue, C, . . .	46	2	0	15	24	2	41
Uneaten residue, D, . . .	138	8	1	46	68	9	123
Actually eaten, A, . . .	15,000	540	105	1,605	930	315	3,180
Actually eaten, B, . . .	14,956	537	105	1,591	912	308	3,145
Actually eaten, C, . . .	14,954	538	105	1,590	906	313	3,139
Actually eaten, D, . . .	14,862	532	104	1,559	862	306	3,057
<i>Feces for 5 days.</i>							
Sheep A, . . .	1,535	129	68	333	566	381	1,096
Sheep B, . . .	1,383	116	57	307	515	336	995
Sheep C, . . .	1,466	142	70	378	510	305	1,100
Sheep D, . . .	1,294	122	72	334	428	290	956
<i>Amounts digested.</i>							
Sheep A, . . .	13,465	411	37	1,272	364	Sheep had	2,084
Sheep B, . . .	13,573	421	48	1,284	397	salt.	2,150
Sheep C, . . .	13,488	396	35	1,212	396		2,039
Sheep D, . . .	13,568	410	32	1,225	434	.....	2,101
<i>Per cent. digested.</i>	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.		Per cent.
Sheep A, . . .	89.7	76.1	35.2	79.2	39.1	.....	65.5
Sheep B, . . .	90.8	78.4	45.7	80.7	43.5	.....	68.4
Sheep C, . . .	90.2	73.6	33.3	76.2	43.7	.....	65.0
Sheep D, . . .	91.2	77.1	30.7	78.5	50.3	.....	68.7
Average,	90.5	76.2	36.0	78.6	44.3	.....	66.8

DIGESTION EXPERIMENT NO. 47.—CONTINUED.

Heat of combustion of food for five days and total available energy.

	HEATS OF COMBUSTION.				Total available energy.	Per cent. available energy.
	Of food eaten.	Of feces.	Of food digested.	Of urine. Estimated.		
	Calories.	Calories.	Calories.	Calories.	Calories.	Per cent.
Sheep A,	15,255	5,833	9,422	470	8,952	58.6
Sheep B,	15,092	5,206	9,886	467	9,419	62.4
Sheep C,	15,061	5,761	9,300	467	8,833	58.6
Sheep D,	14,681	5,107	9,574	463	9,111	62.0
Average, . . . . .	.....	.....	.....	.....	.....	60.4

DIGESTION EXPERIMENT NO. 48. SWEET CORN FODDER (FED GREEN).

Composition of feeding stuffs and feces.

Laboratory No.		Water.	Protein. N. X 6.25.	Fat.	Nitrogen free extract.	Fiber.	Ash.	Organic matter.	Heat of combustion.*
	<i>Feeding stuff.</i>								
	Branching sweet corn.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Calories
1,885	Sample 1,	78.5	1.9	.6	14.1	3.7	1.2	20.3	932
1,886	Sample 2,	76.6	1.7	.7	16.2	3.6	1.2	22.2	1,008
	Average,	77.5	1.8	.7	15.2	3.6	1.2	21.3	970
	<i>Feces.</i>								
1,869	Sheep C,	4.0	10.4	4.4	43.8	25.8	11.6	84.4	4,189
1,870	Sheep D,	4.0	11.1	2.7	45.3	21.8	15.1	80.9	4,073
	<i>Uneaten residue.</i>								
1,890	Sheep C,	4.9	7.1	1.9	59.5	23.2	3.4	91.7	4,195
1,892	Sheep D,	4.8	4.4	1.8	32.2	51.7	5.1	90.1	4,106

* Per gram as determined.

DIGESTION EXPERIMENT NO. 48.—CONTINUED.

Weights of food eaten, and of feces for five days, and weights and per cents. of nutrients digested.

	Total weight.	Protein. N. $\times 6.25$.	Fat.	Nitrogen free extract.	Fiber.	Ash.	Organic matter.
<i>Eaten in five days.</i>	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep C and D, fed each,	15,000	270	105	2,280	540	180	3,195
Uneaten residue, C, . .	185	13	4	110	43	6	170
Uneaten residue, D, . .	47	2	1	15	24	2	42
Actually eaten, C, . .	14,815	257	101	2,155	512	174	3,025
Actually eaten, D, . .	14,953	268	104	2,250	531	178	3,153
<i>Feces for five days.</i>							
Sheep C,	876	91	38	384	226	102	739
Sheep D,	921	102	25	417	201	139	745
<i>Amounts digested.</i>							
Sheep C,	13,939	166	63	1,771	286	72	2,286
Sheep D,	14,032	166	79	1,833	330	39	2,408
<i>Per cent. digested.</i>		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Sheep C, . . . .	.....	64.6	62.4	82.2	55.8	41.3	75.6
Sheep D, . . . .	.....	61.9	76.0	81.5	62.1	21.9	76.4
Average, . . . .	.....	63.2	69.2	81.8	58.9	31.6	76.0

Heat of combustion of food for five days, and total available energy.

	HEATS OF COMBUSTION.				Total available energy.	Per cent. available energy.
	Of food eaten.	Of feces.	Of food digested.	Of urine. Estimated.		
	Calories.	Calories.	Calories.	Calories.	Calories.	Per cent.
Sheep C,	13,774	3,668	10,106	224	9,882	71.7
Sheep D,	14,357	3,751	10,606	233	10,373	72.2
Average, . . . .	.....	.....	.....	.....	.....	71.9

DIGESTION EXPERIMENT NO. 49. BARLEY AND PEA FODDER (FED GREEN).

Composition of feeding stuffs and feces.

Laboratory No.		Water.	Protein. N. $\times 6.25$.	Fat.	Nitrogen free extract.	Fiber.	Ash.	Organic matter.	Heat of combustion.*
	<i>Feeding stuff.</i>								
	Barley and pease.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Calories
1,913	Sample 1,	75.4	4.0	1.0	12.1	5.7	1.8	22.8	1,073
1,914	Sample 2,	74.1	4.0	1.0	12.7	6.1	2.1	23.8	1,108
	Average,	74.7	4.0	1.0	12.4	5.9	2.0	23.3	1,091
	<i>Feces.</i>								
1,917	Sheep A,	5.2	12.2	4.9	37.9	28.1	11.7	83.1	4,366
1,918	Sheep B,	3.8	12.3	5.4	38.0	29.1	11.4	84.8	4,489

* Per gram as determined.

DIGESTION EXPERIMENT NO. 49.—CONTINUED.

Weights of food eaten, and of feces for five days, and per cents. of nutrients digested.

	Total weight.	Protein. N. \times 6.25.	Fat.	Nitrogen free extract.	Fiber.	Ash.	Organic matter.
<i>Eaten in five days.</i>	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep A, and B, each,	14,000	560	140	1,736	826	280	3,262
<i>Feces for five days.</i>							
Sheep A,	1,136	139	56	430	319	133	944
Sheep B,	1,105	136	60	420	321	126	937
<i>Amounts digested.</i>							
Sheep A,	12,864	421	84	1,306	507	147	2,318
Sheep B,	12,895	424	80	1,316	505	154	2,325
<i>Per cent. digested.</i>		Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.
Sheep A,		75.2	60.0	75.2	61.4	52.5	71.1
Sheep B,		73.9	57.1	75.8	61.1	55.0	71.3
Average,		74.5	58.5	75.5	61.2	53.7	71.2

Heat of combustion of food for five days, and total available energy.

	HEATS OF COMBUSTION.				Total available energy.	Per cent. available energy.
	Of food eaten.	Of feces.	Of food digested.	Of urine. Estimated		
	Calories.	Calories.	Calories.	Calories.	Calories.	Per cent.
Sheep A,	15,274	4,960	10,314	365	9,949	65.1
Sheep B,	15,274	4,960	10,314	360	9,954	65.2
Average, . . . .	.....	.....	.....	.....	.....	65.2

DIGESTION EXPERIMENT NO. 50. BARLEY FODDER (FED GREEN).

Composition of feeding stuffs and feces.

Labora- tory. No.		Water.	Protein. N. \times 6.25.	Fat.	Nitrogen free extract.	Fiber.	Ash.	Organic matter.	Heat of combustion.*
	<i>Feeding stuff.</i>								
	Barley fodder.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Calories
1,915	Sample 1, . . .	73.0	3.1	.8	15.1	6.0	2.0	25.0	1,138
1,916	Sample 2, . . .	71.3	3.2	.9	16.0	6.6	2.0	26.7	1,231
	Average,	72.2	3.2	.8	15.5	6.3	2.0	25.8	1,185
	<i>Feces.</i>								
1,919	Sheep C, . . .	3.3	9.0	4.0	40.3	31.9	11.5	85.2	4,433
1,920	Sheep D, . . .	3.8	11.8	4.5	42.7	24.7	12.5	83.7	4,383

* Per gram as determined.

DIGESTION EXPERIMENT NO. 50.—CONTINUED.

Weights of food eaten, and of feces for five days, and per cents. of nutrients digested.

	Total weight.	Protein. N.×6.25.	Fat.	Nitrogen free extract.	Fiber.	Ash.	Organic matter.
<i>Eaten in 5 days.</i>	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep C, and D, each,	14,000	448	112	2,170	882	280	3,612
<i>Feces for 5 days.</i>							
Sheep C,	1,460	131	58	588	466	168	1,243
Sheep D,	1,262	149	56	539	312	158	1,056
<i>Amounts digested.</i>							
Sheep C,	12,540	317	54	1,582	416	112	2,369
Sheep D,	12,738	299	56	1,631	570	122	2,556
<i>Per cent. digested.</i>		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Sheep C,		70.8	48.2	72.9	47.2	40.0	65.6
Sheep D,		66.7	50.0	75.2	64.6	43.6	70.8
Average,		68.7	49.1	74.0	55.9	41.8	68.2

Heat of combustion of food for five days, and total available energy.

	HEATS OF COMBUSTION.				Total available energy.	Per cent. available energy.
	Of food eaten.	Of feces.	Of food digested.	Of urine Estimated.		
	Calories.	Calories.	Calories.	Calories.	Calories.	Per cent.
Sheep C,	16,590	6,472	10,118	276	9,842	59.3
Sheep D,	16,590	5,531	11,059	260	10,799	65.1
Average,						62.2

DIGESTION EXPERIMENT NO. 51. FINE ROWEN HAY.

Composition of feeding stuffs and feces.

Labora- tory No.	Water.	Protein. N.×6.25.	Fat.	Nitrogen free extract.	Fiber.	Ash.	Organic matter.	Heat of combustion.*
	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Calories
1,940 <i>Feeding stuff.</i> Fine rowen hay.	12.0	15.3	3.5	37.7	25.1	6.4	81.6	3,962
<i>Feces.</i>								
1,945 Sheep A,	6.8	11.8	5.5	39.9	25.6	10.4	82.8	4,451
1,946 Sheep B,	6.8	11.3	5.4	41.0	25.8	9.7	83.5	4,430
1,947 Sheep C,	6.6	11.4	5.6	41.5	25.0	9.9	83.5	4,482
1,948 Sheep D,	6.6	14.1	5.7	40.9	22.1	10.6	82.8	4,528
<i>Uneaten residue.</i>								
1,941 Sheep D,	8.2	16.1	3.4	38.8	26.3	7.2	84.6	4,110

*Per gram, as determined.

DIGESTION EXPERIMENT NO. 51.—CONTINUED.

Weights of food eaten, and of feces for five days, and per cents. of nutrients digested.

	Total weight.	Protein. N. $\times 6.25$.	Fat.	Nitrogen. free extract.	Fiber.	Ash.	Organic matter.
<i>Eaten in five days.</i>	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep A, B, C, D, fed each.	3,500	536	123	1,319	878	224	2,856
Uneaten residue, D, .	159	26	5	62	42	11	135
Actually eaten, A, .	3,500	536	123	1,319	878	224	2,856
Actually eaten, B, .	3,500	536	123	1,319	878	224	2,856
Actually eaten, C, .	3,500	536	123	1,319	878	224	2,856
Actually eaten, D, .	3,341	510	118	1,257	836	213	2,721
<i>Feces for five days.</i>							
Sheep A,	1,257	148	69	502	322	131	1,041
Sheep B,	1,276	144	69	523	329	124	1,065
Sheep C,	1,237	141	69	513	309	122	1,032
Sheep D,	1,047	148	60	428	231	111	867
<i>Amounts digested.</i>							
Sheep A,	2,243	388	54	817	556	97	1,815
Sheep B,	2,224	392	54	796	549	104	1,791
Sheep C,	2,263	395	54	806	569	106	1,824
Sheep D,	2,294	362	58	829	605	106	1,854
<i>Per cent. digested.</i>		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Sheep A, . . . .	....	72.4	43.9	61.9	63.3	42.6	63.6
Sheep B, . . . .	....	73.1	43.9	60.4	62.5	45.6	62.7
Sheep C, . . . .	....	73.7	43.9	61.1	64.8	46.5	63.9
Sheep D, . . . .	....	71.0	49.2	65.9	72.4	48.9	68.1
Average, . . . .	....	72.5	45.2	62.3	65.7	45.9	64.6

Heat of combustion of food for five days, and total available energy.

	HEATS OF COMBUSTION.				Total available energy.	Per cent. available energy.
	Of food eaten.	Of feces.	Of food digested.	Of urine. Estimated.		
	Calories.	Calories.	Calories.	Calories.	Calories.	Per cent.
Sheep A,	13,867	5,595	8,272	337	7,935	57.2
Sheep B,	13,867	5,652	8,215	341	7,874	56.8
Sheep C,	13,867	5,544	8,323	343	7,980	57.6
Sheep D,	13,214	4,741	8,473	315	8,158	61.7
Average, . . . .	.....	.....	.....	....	.....	58.3

DIGESTION EXPERIMENT No. 52. FINE ROWEN HAY AND CLEVELAND FLAX MEAL.

Composition of feeding stuffs and feces.

Laboratory No.		Water.	Protein. N. $\times 6.25$.	Fat.	Nitrogen free extract.	Fiber.	Ash.	Organic matter.	Heat of combustion.*
	<i>Feeding stuff.</i>	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Calories
1,943	Rowen hay,	10.7	16.0	3.8	31.9	30.6	7.0	82.3	3,990
1,935	Cleveland flax meal, .	9.2	38.4	2.6	33.1	12.3	4.4	86.4	4,155
	<i>Feces.</i>								
1,951	Sheep A,	9.5	14.9	4.3	35.7	22.1	13.5	77.0	4,105
1,952	Sheep C,	9.0	13.9	4.9	37.8	23.6	10.8	80.2	4,342
1,953	Sheep D,	8.8	13.4	5.0	39.6	22.7	10.5	80.7	4,336

* Per gram, as determined.

Weights of food eaten, and of feces for five days, and per cents. of nutrients digested.

	Total weight.	Protein. N. $\times 6.25$.	Fat.	Nitrogen free extract.	Fiber.	Ash.	Organic matter.
<i>Eaten in five days.</i>	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep A,	3,000	704	102	969	735	184	2,510
Sheep C,	3,000	704	102	969	735	184	2,510
Sheep D,	2,500	512	89	804	673	162	2,078
<i>Feces for five days.</i>							
Sheep A,	1,042	155	45	372	230	141	802
Sheep C,	933	130	46	353	220	100	749
Sheep D,	891	119	45	353	202	94	719
<i>Amounts digested.</i>							
Sheep A,		549	57	597	505	43	1,708
Sheep C,		574	56	616	515	84	1,761
Sheep D,		393	44	451	471	68	1,359
<i>Per cent. digested.</i>							
Sheep A,		78.0	55.9	61.6	68.7	23.4	68.1
Sheep C,		81.5	54.9	63.6	70.1	45.7	70.2
Sheep D,		76.8	49.4	56.1	70.0	42.0	65.4
Average,		78.8	53.4	60.4	69.6	37.0	67.9

Heat of combustion of food for five days and total available energy.

	HEATS OF COMBUSTION.				Total available energy.	Per cent. available energy.
	Of food eaten.	Of feces.	Of food digested.	Of urine. Estimated.		
	Calories.	Calories.	Calories.	Calories.	Calories.	Per ct.
Sheep A,	12,135	4,277	7,858	652	7,206	59.4
Sheep C,	12,135	4,051	8,084	673	7,411	61.1
Sheep D,	10,057	3,863	6,194	516	5,678	56.5
Average, . . . .	.....	.....	.....	.....	.....	59.0

DIGESTION EXPERIMENT No. 53. FINE ROWEN HAY AND QUAKER OAT FEED.

Composition of feeding stuffs and feces.

Laboratory No.		Water.	Protein. N. $\times 6.25$.	Fat.	Nitrogen free extract.	Fiber.	Ash.	Organic matter.	Heat of combustion.*
	<i>Feeding stuff.</i>	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Calories
1,982	Fine rowen hay, .	6.7	13.4	4.2	41.0	27.3	7.4	85.9	4,449
1,944	Quaker oat feed, .	7.9	9.2	2.2	54.5	20.7	5.5	86.6	3,984
	<i>Feces.</i>								
1,954	Sheep A, .	7.6	8.7	2.4	44.1	26.1	11.1	81.3	4,062
1,955	Sheep C, .	8.8	8.4	5.0	42.0	25.6	10.2	81.0	4,158
1,956	Sheep D, .	7.1	9.1	3.0	44.5	26.6	9.7	83.2	4,200

* Per gram as determined.

Weights of food eaten, and of feces for five days, and per cents. of nutrients digested.

	Total weight.	Protein. N. $\times 6.25$.	Fat.	Nitrogen free extract.	Fiber.	Ash.	Organic matter.
<i>Eaten in 5 days.</i>	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.	Grams.
Sheep A, C, and D, each,	5,000	565	160	2,387	1,201	323	4,313
<i>Feces for 5 days.</i>							
Sheep A,	2,094	182	50	924	547	232	1,703
Sheep C,	1,957	164	98	822	501	200	1,585
Sheep D,	2,071	188	62	922	551	201	1,723
<i>Amounts digested.</i>							
Sheep A,	2,906	383	110	1,463	654	91	2,610
Sheep C,	3,043	401	62	1,565	700	123	2,728
Sheep D,	2,929	377	98	1,465	650	122	2,590
<i>Per cent. digested.</i>		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Sheep A, . . . . .	.....	67.8	68.8	61.3	54.5	28.2	60.5
Sheep C, . . . . .	.....	71.0	38.8	65.6	58.3	38.1	63.3
Sheep D, . . . . .	.....	66.7	61.3	61.4	54.1	37.8	60.1
Average, . . . . .	.....	68.5	56.3	62.8	55.6	34.7	61.3

Heat of combustion of food for five days and total available energy.

	HEATS OF COMBUSTION.				Total available energy.	Per cent. available energy.
	Of food eaten.	Of feces.	Of food digested.	Of urine. Estimated.		
	Calories.	Calories.	Calories.	Calories.	Calories.	Per cent.
Sheep A,	21,083	8,506	12,577	333	12,244	58.1
Sheep C,	21,083	8,137	12,946	349	12,597	59.8
Sheep D,	21,083	8,698	12,385	328	12,057	57.2
Average, . . . . .	.....	.....	.....	.....	.....	58.4

FEEDING EXPERIMENTS ON THE WINTER FATTENING OF LAMBS.

BY CHAS. E. LYMAN.

(REPORTED BY C. S. PHELPS.)

The investigation here reported was undertaken with the idea of gaining some light on the value of different rations and different feeding stuffs on the winter fattening of lambs. The lambs were separated into three lots. The first and second lot included 10 lambs each. They were mostly selected grade Shropshires, considerably larger and rather more vigorous than the average of our feeding lambs. The third lot consisted of 200 lambs of medium quality, taken from a carload purchased in Chicago. They were range-fed lambs with quite a proportion of the blood of the "down" breeds, and were considered fairly good feeders.

Description of Experiments with Lambs of First and Second Lots.—The feeding materials used in these tests were clover rowen hay of good quality and well ripened corn silage with a large proportion of ears, whole corn of the common Western varieties, fine wheat bran, and pea meal. The last is a by-product from the preparation of split peas, and consists largely of the smaller peas which are culled out and mixed with the hulls, and the whole ground and sold under the name of pea meal.

Lot 1 had the narrow ration, which was planned to consist of three-fourths pea meal and one-fourth corn, with about one,

* During the winter of 1897-98, the Station co-operated with Chas. E. Lyman of Middlefield, Conn., in conducting some feeding experiments on the fattening of lambs. Mr. Lyman feeds each winter about 4,000 lambs, which are bought during the fall months in the Buffalo or Chicago markets, and thus has favorable opportunities for selecting desirable stock for feeding experiments. The chief purpose of the experiment was to compare the effects of a ration giving a somewhat wide nutritive ratio, with those of one giving a rather narrow nutritive ratio, for fattening purposes. Two small lots of lambs were used for this part of the experiment. In addition a test was laid out with a large number of lambs, with what was designated as a "business ration," to ascertain the profits of feeding. This ration was considered by Mr. Lyman to be nearly a balanced ration for fattening lambs. Thus there was an opportunity afforded for comparing what is commonly known as a narrow ration, a wide ration, and a "balanced" ration.—

W. O. ATWATER.

part clover rowen to two parts of silage by weight. After feeding this ration for a week or ten days it became apparent that the experiment could not be carried out on the lines laid down, if profitable gains were to be expected, as the lambs were not disposing of a satisfactory amount of feed. At the end of about ten days bran was substituted for a part of the pea meal, making the ration one-half pea meal, one-fourth bran, and one-fourth corn.

Lot 2 was fed the wider ration, which consisted of three parts corn and one part pea meal, the corn silage and hay being the same in quality as for Lot 1. The proportion of the grain feeds used in the ration remained the same throughout the experiment. The coarse fodders used consisted of nearly two parts of corn silage to one part of clover rowen for the first period, and two parts of corn silage to one and one-half parts of clover rowen for the second period. The total grain ration for the second period was also increased. The amounts of the various feeding stuffs, and the total nutrients consumed per day, on the average, by the first two lots of lambs for each of the two periods, are shown in the following tables. The proportions of total dry matter and of digestible nutrients were estimated from average figures for composition and digestibility of the several kinds of food materials.

TABLE 41.—*Total weight of different feeding stuffs and of digestible nutrients in daily rations fed to ten lambs of the first lot.*

Feeds used.	Total weight.	Total dry matter.	DIGESTIBLE NUTRIENTS.			Nutritive ratio.
			Protein.	Fat.	Carbo-hydrates.	
<i>Period I—31 days.</i>	lbs.	lbs.	lbs.	lbs.	lbs.	
Corn,	4	3.5	.23	.12	2.61	
Bran,	2	1.8	.24	.05	.77	
Pea meal,	10	9.0	1.68	.06	5.18	
Clover rowen,	9	8.0	.88	.19	3.30	
Silage,	18	4.4	.18	.13	2.54	
		26.7	3.21	.55	14.40	1:4.9
<i>Period II—31 days.</i>						
Corn,	5½	4.8	.32	.17	3.59	
Bran,	5½	4.8	.66	.15	2.12	
Pea meal,	10	9.0	1.68	.06	5.18	
Clover rowen,	7	6.2	.69	.15	2.57	
Silage,	14	3.4	.14	.10	1.97	
		28.2	3.49	.63	15.43	1:4.8

TABLE 42.—*Total weight of different feeding stuffs and of digestible nutrients in daily rations fed to ten lambs of the second lot.*

Feeds used.	Total weight.	Total dry matter.	DIGESTIBLE NUTRIENTS.			Nutritive ratio.
			Protein.	Fat.	Carbo-hydrates.	
<i>Period I—31 days.</i>	lbs.	lbs.	lbs.	lbs.	lbs.	
Corn,	14	12.1	.81	.43	9.13	
Pea meal,	4½	4.0	.76	.03	2.33	
Clover rowen,	9	8.0	.88	.19	3.30	
Silage,	17	4.2	.17	.12	2.40	
		28.3	2.62	.77	17.16	1 : 7.2
<i>Period II—31 days.</i>						
Corn,	17	14.7	.99	.53	11.08	
Pea meal,	5½	4.9	.92	.03	2.85	
Clover rowen,	9	8.0	.88	.19	2.40	
Silage,	12	3.0	.12	.08	1.69	
		30.6	2.91	.83	18.02	1 : 6.8

Cost of Producing 100 Pounds Gain in Live Weight.—The experiment began December 21. The two lots of 10 lambs each were very nearly of a size, the total weight of the lambs of Lot 1 being 13 pounds more than that of Lot 2. When the experiment began, Lot 1 weighed 882 pounds. On January 21 the weight was 987 pounds, making a gain in 31 days of 105 pounds, or an average of 10½ pounds for each lamb. During the 31 days of the second period the gain in weight was 137 pounds, or 13.7 pounds per lamb.

Lot 2 on December 21 weighed 869 pounds, while on January 21 this lot weighed 1,034 pounds, making a gain of 165 pounds in 31 days, or 16½ pounds per lamb. On February 21 the weight of this lot of lambs was 1,150 pounds, giving a gain of 116 pounds in 31 days, or 11.6 pounds per lamb during the second period. It will be seen that the gains for the second lot, which were fed the wide rations, are considerably larger than for the first lot, which had the narrow ration.

The wide ration (Lot 2) was somewhat more expensive than the narrow ration (Lot 1), but the average cost of 100 pounds of increase was 16 cents less for the lambs fed the wide ration. The following table shows the gains for each period, the daily cost of the rations, and the cost of 100 pounds of increase in live weight:

TABLE 43.—*Pecuniary economy of the different rations fed lots one and two.*

DAILY RATION.		Lot No.	PERIOD.		Total weight of ten lambs at the beginning and end of period.	Gain for period.	Cost of ration per day.	Total cost of producing 100 lbs. gain live weight.
Character and amounts.	Total weight.		No.	Duration.				
<i>Narrow ration.</i>	lbs.			1897-8.	lbs.	lbs.	cents.	
Concentrated feeds: pea meal, 10; corn, 4; bran, 2, . . .	16	1	1	Dec. 21 to Jan. 21.	882	105	18.0	\$5.31
Coarse fodders: clover rowen, 9; silage, 18, . . .	27							
Concentrated feeds: pea meal, 10; corn, 5½; bran, 5½, . . .	21	1	2	Jan. 21 to Feb. 21.	987	137	20.1	4.55
Coarse fodders: clover rowen, 7; silage, 14, . . .	21							
Total, . . .						242		
Average, . . .							19.1	4.93
<i>Wide ration.</i>								
Concentrated foods: corn, 14; pea meal, 4½, . . .	18½	2	1	Dec. 21 to Jan. 21.	869	165	19.8	3.72
Coarse fodders: clover rowen, 9; silage, 17, . . .	26							
Concentrated foods: corn, 17; pea meal, 5½, . . .	22½	2	2	Jan. 21 to Feb. 21.	1,034	116	21.8	5.82
Coarse fodders: clover rowen, 9; silage, 12, . . .	21							
Total, . . .						281		
Average, . . .							20.8	4.77

Description of Experiments with Lambs of the Third Lot.—

The lambs in this test consisted of a lot of 200 selected from a carload of feeding lambs bought in Chicago, November 17, 1897. They arrived in Middlefield, Conn., on November 20, having been three days in transit. They were what are called "natives" in Chicago. Nearly all of them had black or smut faces, and apparently carried quite a proportion of the blood of the "down" breeds. They were considered good feeders. The lambs were sheared a few days after arrival, and clipped an average of 3¼ pounds of medium wool per lamb. The lot of 200 lambs averaged 73½ pounds each in weight when the experiment began, December 1, 1897. During the ten days previous, while they were being "put on to their feed," they gained an average of nearly five pounds each above their weight in Chicago.

There were three feeding periods in the test, of 15, 16, and

17 days each, and the rations fed during the three periods varied slightly. The feeding stuffs used in this test were similar to those used in tests 1 and 2. The amount and proportions of the clover rowen and corn silage were nearly the same throughout the three periods. Any feed left in the racks was removed after a reasonable length of time, re-weighed, and deducted. The amount of refuse feed, however, was very slight. At the start, corn and pea meal in equal parts were used. After the first two or three weeks it became evident that this was not a ration upon which the animals would continue to thrive and remain vigorous. Toward the end of the first period some of the lambs were becoming lame; and, on the whole, the lambs were not making good growth.

After feeding about ten days in the second period, a small proportion of wheat bran was added to the ration. The bran apparently was not added in sufficient quantities, and the gains made during this period were not equal to the gains made in the first period. During the third period there was added a larger proportion of wheat bran, making the ration one part each of pea meal and bran, with one and one-third parts of corn. This had a very beneficial effect, as seen by the large increase in weight during the third period.

The kinds and weights of feed and the total digestible nutrients fed per day during the three periods are shown in Table 44 beyond. The proportions of total dry matter and of digestible nutrients were estimated from average figures for composition and digestibility of the several kinds of food materials.

Cost of Producing 100 Pounds Gain in Live Weight. — At the beginning of the first period, December 1, the 200 lambs weighed 14,700 pounds, and their weight December 15 was 15,840 pounds, giving a gain of 1,140 pounds in 15 days, or at the rate of 5.7 pounds per lamb for the period.

The second feeding period was from December 16 to January 1, 16 days. Near the end of this period it became necessary to butcher four lambs that were losing the use of their limbs, and their live weight was taken and included in the total weights at the end of the experiment. The weight of 200 lambs on December 16, was 15,840 pounds. The weight of 200 lambs January 1 (including four killed during the period) was 16,530 pounds, showing a gain in 16 days of 690 pounds.

TABLE 44.—*Total weight of different feeding stuffs and of digestible nutrients in the daily rations fed to two hundred lambs of the third lot.*

Feeds used.	Total weight.	Dry matter.	DIGESTIBLE NUTRIENTS.			Nutritive ratio.
			Protein.	Fat.	Carbo-hydrates.	
<i>Period I.</i>	lbs.	lbs.	lbs.	lbs.	lbs.	
Corn,	167	144.3	9.69	5.18	108.88	
Pea meal,	167	149.5	28.06	1.00	86.51	
Clover rowen,	148	131.4	14.50	3.11	54.32	
Silage,	325	80.0	3.25	2.28	45.83	
		505.2	55.50	11.57	295.54	1 : 5.8
<i>Period II.</i>						
Corn,	181	156.4	10.50	5.61	118.01	
Pea meal,	138	123.5	23.18	0.83	71.48	
Bran,	9	7.9	1.07	0.25	3.47	
Clover rowen,	141	125.2	13.82	2.96	51.75	
Silage,	316	77.7	3.16	2.21	44.56	
		490.7	51.73	11.86	289.27	1 : 6.1
<i>Period III. (196 lambs.)</i>						
Corn,	132	114.0	7.66	4.09	86.06	
Bran,	100	88.1	11.90	2.80	38.50	
Pea meal,	100	89.5	16.80	0.60	51.80	
Clover rowen,	146	129.6	14.31	3.07	53.58	
Silage,	301	74.0	3.01	2.11	42.44	
		495.2	53.68	12.67	272.38	1 : 5.6
<i>Digestible nutrients (calculated for ten lambs, 1 day).</i>						
<i>Period I.</i>		25.3	2.78	.58	14.78	
<i>Period II.</i>		24.5	2.59	.59	14.46	
<i>Period III.</i>		25.3	2.74	.65	14.00	

The third feeding period comprised the first 17 days of January. During this period it became necessary to butcher two more lambs from the same cause as before, and by accident one died from rupture. The gains during this period were as follows: Weight of 196 lambs January 1, 1898, 16,255 pounds; weight of 196 lambs on January 18 (including two butchered and one died), 17,485 pounds; 196 lambs gained in 17 days 1,230 pounds. When reduced to a period of 15 days, this gives a gain of 1,085 pounds, or at the rate of 5.54 pounds per lamb. The experiment was not continued longer, as the lambs were as fat and as heavy as the market required.

In estimating the cost of the rations, hay has been valued at \$10 per ton, corn silage at \$3 per ton, corn at 38½c. per bushel (56 pounds), bran at \$15, and pea meal at \$13 per ton. The cost of producing 100 pounds of gain in live weight for the whole period was \$7.91, while in the third period the cost was \$4.85. In the first period the gain was made at the rate of 5.70 pounds, in the second period 3.24 pounds, and in the third period 5.54 pounds per lamb for uniform periods of 15 days.

The details of this experiment with the third lot of lambs are summarized in the following table:

TABLE 45.—*Pecuniary economy of different rations fed lot three.*

DAILY RATION.		Total No. of lambs.	PERIOD.		Total weight of lambs at beginning and end of period.	Gain for period.	Cost of ration per day.	Total cost of producing 100 lbs. gain live weight.
Kinds and amounts of each.	Total weight.		No.	Duration.				
	lbs.				lbs.	lbs.		
Corn, 167; pea meal, 167, .	334 }	200	1 }	1897-8.				
Clover rowen, 148; silage, 325.	473 }			Dec. 1 to Dec. 16.	14,700 } 15,840 }	1,140	\$3.48	\$4.58
Corn, 181; pea meal, 138; bran, 9, .	328 }	200	2 }	Dec. 16 to Jan. 1.	15,840 } 16,530 }	690	3.41	7.91
Clover rowen, 141; silage, 316.	457 }							
Corn, 132; pea meal, 100; bran, 100,	332 }	196	3 }	Jan. 1 to Jan. 16.	16,255 } 17,485 }	1,230	3.51	4.85
Clover rowen, 146; silage, 301.	447 }							

WHAT THE EXPERIMENTS AND OUR EXPERIENCE TEACH.

Taken together with our experience in feeding 2,000 to 4,000 lambs each winter, the experiments tend to show that a mixture of feeding stuffs so combined as to furnish a palatable and wholesome ration is of greater importance in feeding lambs than the chemical composition of the ration. Lambs, when first placed on a grain ration, will usually make rapid gains for a short time irrespective of the composition of the ration, but unless the ration is a palatable one and well suited for growth as well as fattening, the lambs will not continue to eat vigor-

ously, and the gains will soon be greatly reduced. Our experience has shown that wheat bran should constitute a considerable part of the ration if good gains are to be expected for periods of considerable length. This was well illustrated in feeding the 10 lambs designated as Lot 2. In the first period the gains were at the rate of 16.5 pounds per lamb per month of 31 days, while in the second period, although the ration was considerably larger, the gain was reduced to 11.6 pounds per lamb. The absence of bran in this ration, we feel, accounts in a great measure for the lower gains after the feeding had been continued for quite a time. In the case of Lot 1 the ration in the second period was somewhat heavier than in the first period, the change being mainly the substitution of bran for a part of the corn, and in this case the gains in the second period over those of the first were increased 3.2 pounds per lamb for the period of 31 days. The absence of bran from the ration in the case of lambs which are growing rapidly is very likely to occasion a weakness of the legs and a general lack of vigor.

It is desirable to induce the lambs to eat as large a grain ration as possible if rapid gains are to be expected. In order to do this the coarse fodder of the ration should be as wholesome and nutritious as possible. For a dry feed nothing has proven superior to clover hay in our experience. We have had a large experience in the use of silage in connection with lamb feeding, and have generally got satisfactory results from its use when the quality of the silage has been good. Only silage from well ripened corn will give satisfactory results. Such varieties should be grown as will mature suitable for seed in this climate, and the corn should not be harvested for silage until the ears are well ripened and a large part of the water has escaped from the stalks and leaves. Silage with a large amount of water is sour and is always poorly eaten by lambs.

The ration which in the long run has given us the most satisfactory results in feeding lambs is one very similar to that used in the third period with the large lot of lambs. A grain ration consisting of one-third corn, one-third bran, and one-third pea meal by weight, together with coarse fodder consisting of clover hay or clover rowen one part, and corn silage two parts, has, on the whole, given us very satisfactory returns.

ANALYSES OF FODDERS AND FEEDING STUFFS.

REPORTED BY W. O. ATWATER AND F. G. BENEDICT.

In connection with the work of the Station during the past year various materials used as food for animals have been analyzed. Some of these analyses were made in connection with studies of rations fed to milch cows and are included in this report, although the details of the investigations are reserved for future publication. Others were made in connection with the digestion experiments with sheep, and still others in connection with the field and plot experiments with different crops and fertilizers, referred to in other parts of this report. Many of the analyses of forage plants grown on the experimental plots and the feeding stuffs used in the digestion experiments were made during the year 1897-1898, but as the experiments to which they belonged were not discussed in the Report for 1897, they were reserved for publication in the present report. Besides the analyses of fodders and feeding stuffs many analyses of uneaten residue and of feces were made in connection with the sheep digestion experiments reported above. These analyses have already been given in connection with the details of the experiments and are not included in the following tables.

The methods of analyses were, in general, those recommended by the Association of Official Agricultural Chemists, though minor modifications have been found desirable.

The results of the analyses as calculated to water content at the time of sampling are given in Table 46, page 235. In this table the materials are grouped somewhat according to their water content at the time of taking the sample, as follows:

Green fodders, silage, cured hay and fodder, grain and milling by-products.

The percentage composition of the water-free substance (dry matter) is shown in Table 47, page 239. The fuel values per pound are calculated according to the usage, which assumes that one-hundredth of a pound of protein or carbohydrates has a fuel value of 18.6; a hundredth of a pound of fat, 42.2 calories. It has been pointed out in previous reports, and we reiterate with emphasis, that these factors for fuel values are

in no sense to be regarded as accurately settled. Such calculations of fuel values afford an approximate method for comparing different foods and feeding stuffs with respect to the quantities of energy which they are capable of yielding to the body. But these figures do not give an exact measure of the nutritive effects of the food materials. Indeed, we think they are in some cases quite far from such a measure. The total energy in the different feeding stuffs as obtained by burning with the bomb calorimeter was also determined in many instances. The whole subject of fuel values and nutritive effects of materials used as the food of animals and man is now being studied by the Station.

Two sets of averages are given in Tables 46 and 47 beyond. The first is the average of the samples published for the first time in the present report. The second is the average of all analyses of similar materials made up to the present time in this laboratory.

DESCRIPTION OF SAMPLES.

The samples of feeding stuffs, the analyses of which are reported in the following tables, may be described as follows:

GREEN FODDERS AND GRASSES.

1,967, 1,968, 1,969, 1,970. *Brome grass (Bromus inermis)*. — Grown in the Station grass garden in 1898. Samples were taken July 2d, when just past bloom.

No. 1,967 was from a plot to which no fertilizer had been applied; growth, small, thin, pale in color, with little bottom growth.

No. 1,968 was from a plot which had dissolved bone-black at the rate of 320 pounds per acre and muriate of potash at the rate of 160 pounds per acre. Growth, much like growth on plot without fertilizers. Thin, pale in color, but little bottom growth.

No. 1,969 was from a plot which had dissolved bone-black and muriate of potash at the same rate as 1,968, and, in addition, nitrate of soda at the rate of 160 pounds per acre. Growth, quite heavy, fair color, thick, and leafy.

No. 1,970 was from a plot which had dissolved boneblack and muriate of potash at the same rate as 1,968, and, in addition, nitrate of soda at the rate of 480 pounds per acre. Growth, dense, heavy growth, dark green color, thick and leafy.

1,856, 1,975, 1,855, 1,976, 1,857, 1,977, 1,858, 1,978. *Meadow fescue (Festuca elatior)*. — Grown in the Station grass garden in 1897-1898. Samples 1,855, 1,856, 1,857, 1,858, were taken on June 25, 1897, when a little past full bloom. Samples 1,975, 1,976, 1,977, 1,978, were taken July 2, 1898, when just past bloom.

No. 1,856 and 1,975 were from plots which had no fertilizer. Growth for each season was much the same. Pale in color, thin and small, with very little leaf and bottom growth.

Nos. 1,855 and 1,976 were from plots which had dissolved boneblack at the rate of 320 pounds per acre, and muriate of potash at the rate of 160 pounds per acre. Growth, slightly heavier yield than on plots with no fertilizer but grass, pale in color, thin and not leafy.

Nos. 1,857 and 1,977 were from plots which had dissolved boneblack and muriate of potash at the same rate as 1,855, and, in addition, nitrate of soda at the rate of 160 pounds per acre. Growth, fair in color, heavy growth both seasons, not as dense and leafy as on plot with largest amount of nitrogen.

Nos. 1,858 and 1,978 were from plots which had dissolved boneblack and muriate of potash at the same rate as 1,855, and, in addition, nitrate of soda at the rate of 480 pounds per acre. Growth, very heavy, dark green in color, dense leafy growth, with an especially heavy bottom growth.

1,852, 1,963, 1,851, 1,964, 1,853, 1,965, 1,854, 1,966. *Orchard grass* (*Dactylis glomerata*). — Grown in Station grass garden in 1897 and 1898. Samples 1,852, 1,851, 1,853, 1,854, were taken on June 19, 1897, when a little past full bloom.

Samples 1,963, 1,964, 1,965, 1,966, were taken on June 21, 1898, when just past bloom.

Nos. 1,852 and 1,963 were from a plot which had no fertilizer. Growth, much the same each season, thin, very pale in color, with small amount of bottom growth.

Nos. 1,851 and 1,964 were from plots which had dissolved boneblack at the rate of 320 pounds per acre and muriate of potash at the rate of 160 pounds per acre. Growth, a little heavier each season than on nothing plots, color pale, and bottom growth light.

Nos. 1,853 and 1,965 were from plots which had dissolved boneblack and muriate of potash at the same rate as 1,851, and, in addition, nitrate of soda at the rate of 160 pounds per acre. Growth, much alike each season. Quite heavy, fair color, bottom growth thick.

Nos. 1,854 and 1,966 were from plots which had dissolved boneblack and muriate of potash at the same rate as 1,851 and, in addition, nitrate of soda at the rate of 480 pounds per acre. Growth, very heavy each season, $3\frac{1}{2}$ to 4 ft. tall, very dense bottom growth, rich green color.

1,860, 1,859, 1,861, 1,862. *Red top* (*Agrostis vulgaris*). — Grown in the Station grass garden in 1897. The samples were taken July 24, 1897, in early seed stage, somewhat browned by recent heavy rains.

No. 1,860 was from a plot which had no fertilizer. Growth, small, thin, and spindled, pale in color.

No. 1,859 was from a plot which had dissolved boneblack at the rate of 320 pounds per acre and muriate of potash at the rate of 160 pounds per acre. Growth, a little heavier than on nothing plot, pale in color, small amount of bottom growth.

No. 1,861 was from a plot which had dissolved boneblack and muriate of potash at the same rate as 1,859, and, in addition, nitrate of soda at the rate of 160 pounds per acre. Growth, fair in color, medium heavy with leafy bottom growth.

No. 1,862 was from a plot which had dissolved boneblack and muriate of potash at the same rate as 1,859, and, in addition, nitrate of soda at the rate of 480 pounds per acre. Growth, heavy, rich green in color, dense bottom growth.

1,848, 1,971, 1,847, 1,972, 1,849, 1,973, 1,850, 1,974. *Timothy (Phleum pratense)*. — Grown in the Station grass garden in 1897 and 1898. Samples 1,848, 1,847, 1,849, 1,850, were taken on July 15, 1897, in the early seed stage. Samples 1,971, 1,972, 1,973, 1,974, were taken on July 11, 1898, when just past bloom.

Nos. 1,848 and 1,971 were from plots which had no fertilizer. Growth, thin and pale in color, uneven and small with little bottom growth.

Nos. 1,847 and 1,972 were from plots to which was applied dissolved boneblack at the rate of 320 pounds to the acre and muriate of potash at the rate of 160 pounds per acre. Growth, a little heavier than where no fertilizer was used, color pale, slender, and not leafy.

Nos. 1,849 and 1,973 were from plots which had dissolved boneblack and muriate of potash at the same rate as 1,847, and, in addition, nitrate of soda at the rate of 160 pounds per acre. Growth, quite heavy, fair color, medium amount of leaf growth.

Nos. 1,850 and 1,974 were from plots which had dissolved boneblack and muriate of potash at the same rate as 1,847, and, in addition, nitrate of soda at the rate of 480 pounds per acre. Growth, very heavy and dense, dark green in color and very leafy.

1,872, 1,880, 6,002, 6,003, 1,871, 1,876, 6,004, 6,005, 1,879, 6,006, 1,878, 6,007, 1,877, 6,008, 1,875, 6,009, 1,874, 6,010, 1,873, 6,011. *Cow pea fodder*. — Grown by the Station in 1897 and 1898 as part of a special nitrogen experiment. For a description of the experiment see pages of this Report. Samples 1,871 to 1,880 inclusive were taken on September 28, 1897. At this time there was a full growth of fodder with a few seed pods formed. Samples 6,002 to 6,011 inclusive were taken on October 4, 1898.

Nos. 1,872, 1,880, 6,002, and 6,003 were from a plot which had no fertilizer.

Nos. 1,871, 1,876, 6,004, and 6,005, were from plots which had dissolved boneblack at the rate of 320 pounds per acre and muriate of potash at the rate of 160 pounds per acre.

Nos. 1,879 and 6,006 were from plots which had dissolved boneblack and muriate of potash at the same rate as 1,871, and, in addition, nitrate of soda at the rate of 160 pounds per acre.

Nos. 1,878 and 6,007 were from plots which had dissolved boneblack and muriate of potash at the same rate as 1,871, and, in addition, nitrate of soda at the rate of 320 pounds per acre.

Nos. 1,877 and 6,008 were from plots which had dissolved boneblack and muriate of potash at the same rate as 1,871, and in addition nitrate of soda at the rate of 480 pounds per acre.

Nos. 1,875 and 6,009 were from plots which had dissolved boneblack and muriate of potash at the same rate as 1,871, and in addition sulphate of ammonia at the rate of 120 pounds per acre.

Nos. 1,874 and 6,010 were from plots which had dissolved boneblack and muriate of potash at the same rate as 1,871, and in addition sulphate of ammonia at the rate of 240 pounds per acre.

Nos. 1,873 and 6,011 were from plots which had dissolved boneblack and muriate of potash at the same rate as 1,871, and in addition sulphate of ammonia at the rate of 360 pounds per acre.

1,913, 1,914. *Barley and pea fodder*.—Used in sheep digestion experiment No. 49. The samples were taken October 15, 1897, and October 19, 1897, respectively.

There was but a light crop of barley with seed partially formed. Peas had but a few pods formed and the vines were small.

1,915, 1,916. *Barley fodder*.—Used in sheep digestion experiment No. 50. No. 1,915, sampled October 15, 1897, light crop; seed beginning to form. No. 1,916, sampled October 19, 1897, light crop, seed partially formed.

1,881, 1,882. *Oat and pea fodder*.—Used in sheep digestion experiment No. 46. The samples were taken July 17 and 24, 1897. In the first sample (July 17) the oat seeds were formed, but quite soft, peas nearly out of bloom with many seeds partially formed. In the second sample (July 24) the oat seeds were quite firm and most of the peas were seeded.

1,883, 1,884, 6,001. *Soy bean fodder*.—Used in sheep digestion experiment No. 47. 1,883 and 1,884 were sampled August 28 and September 1, 1897. Condition of growth about the same for each sample. At the time the samples were taken the fodder was well grown and most of pods and many seeds were developed.

No. 6,001. *Green soy bean fodder*.—October 3, 1898. Most of the seed well ripened. Vines beginning to die at bottom. Heavy growth.

1,885, 1,886. *Sweet corn fodder*.—"Branching Sweet" variety. Used in sheep digestion experiment No. 48. Sampled September 17 and September 20, 1897, when seed was somewhat firm, but fodder still quite succulent.

2,000. *Ensilage corn (Ohio white dent)*. October 3, 1898. Seed well ripened. Stalks with many of lower leaves dead.

ENSILAGE.

1,922, 1,927, 1,980, 2,000. *Corn ensilage*.—1,922, 1,927 analyzed in connection with cow-feeding experiments. 1,980 from Storrs College. Sampled February 18, 1898. 2,000 (see page above).

CURED FODDERS AND HAYS.

1,979, 1,983. *Corn stover*.—From Storrs College. Sampled February 10 and April 4, 1898.

1,921. *Hay clover, rowen*.

1,933. *Hay clover* ($\frac{1}{4}$ grasses).

1,984-1,999. *Hungarian Hay*.—From pot experiments Nos. 13-28. Harvested September 3, 1898.

1,926, 1,932, 1,934, 1,937, 1,938, 1,939. *Hay (mixed grasses)*.—Analyzed in connection with cow-feeding experiments.

1,940. *Rowen hay*.—Used in digestion experiment No. 51. Mixed grasses nearly free from clover; harvested in good condition.

1,942, 1,943, 1,982. *Fine rowen hay (mixed grasses)*. Used in sheep digestion experiments Nos. 52, 53, and 54, respectively.

1,981. *Rowen hay*.—From Storrs College. Sampled Feb. 10, 1898.

1,931. *Hay (second quality)*.—Used in cow-feeding experiment.

MILLING AND BY-PRODUCTS.

1,928. *Chicago gluten meal*.—Used in cow-feeding experiment.

1,960, 1,961. *Chicago gluten meal*.—From Storrs College.

1,935. *Cleveland flax meal*.—Used in cow-feeding experiment.

1,925, 1,929, 1,936. *Cotton-seed meal*.—Used in cow-feeding experiments.

1,957, 1,962. *Cotton-seed meal*.—From Storrs College.

1,924. *Quaker oat feed*.—Used in cow-feeding experiment.

1,944. *Quaker oat feed*.—Used in sheep digestion experiment No. 54.

1,923, 1,930. *Wheat bran*.—Used in cow-feeding experiments.

1,958, 1,959. *Wheat bran*.—From Storrs College.

1,836-1,845 and 6,012-6021. *Soy beans*.—Grown by the Station in 1897 and 1898, as part of a special nitrogen experiment.

1,836, 1,837, 6,012, 6,013 were from plots which had no fertilizer.

1,838, 1,839, 6,014, 6,015 were from plots which had dissolved boneblack at the rate of 320 pounds per acre and muriate of potash at the rate of 160 pounds per acre.

1,840, 6,016 were from plots which had dissolved boneblack and muriate of potash at the same rate as 1,838, and in addition nitrate of soda at the rate of 160 pounds per acre.

1,841, 6,017 were from plots which had dissolved boneblack and muriate of potash at the same rate as 1,838, and in addition nitrate of soda at the rate of 320 pounds per acre.

1,842, 6,018 were from plots which had dissolved boneblack and muriate of potash at the same rate as 1,838, and in addition nitrate of soda at the rate of 480 pounds acre.

1,843, 6,019 were from plots which had dissolved boneblack and muriate of potash at the same rate as 1,838, and in addition sulphate of ammonia at the rate of 120 pounds per acre.

1,844, 6,020 were from plots which had dissolved boneblack and muriate of potash at the same rate as 1,838, and in addition sulphate of ammonia at the rate of 240 pounds per acre.

1,845, 6,021 were from plots which had dissolved boneblack and muriate of potash at the same rate as 1,838, and in addition sulphate of ammonia at the rate of 360 pounds per acre.

1,846. *Four o'clock seed*.—From John V. Oberhaltze, Esmeralda, Florida. Sent through Department of Agriculture, Washington, D. C. The whole seed, including both kernel and hulls, was analyzed.

TABLE 46.—*Composition of fodders and feeding stuffs analyzed 1897-98. Calculated to water content at time of taking sample.*

Laboratory No.	Feeding stuffs.	Water.	Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.	Fuel value per pound.
		Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Calories.
<i>Green fodders.</i>								
1,967	Bromus inermis, . . .	61.1	3.2	1.3	19.1	12.4	2.9	700
1,968	" " . . .	63.6	3.0	1.2	18.0	11.2	3.0	650
1,969	" " . . .	64.7	2.8	1.1	17.5	11.3	2.6	635
1,970	" " . . .	71.4	3.6	1.1	12.3	9.4	2.2	515
	Average (4),	65.2	3.1	1.2	16.7	11.1	2.7	625
	Average all analyses (8),	65.6	3.2	1.2	16.9	10.4	2.7	615
1,856	Meadow fescue, . . .	63.8	2.3	.9	16.0	14.6	2.4	650
1,975	" " . . .	61.0	2.6	1.0	20.6	12.3	2.5	700
1,855	" " . . .	65.2	2.1	.9	16.7	12.4	2.7	620
1,976	" " . . .	64.7	2.4	.9	17.4	11.9	2.7	630
1,857	" " . . .	67.8	2.5	.9	15.1	11.4	2.3	575
1,977	" " . . .	64.7	2.5	1.1	17.7	11.5	2.5	635
1,858	" " . . .	72.1	3.3	1.0	12.0	9.4	2.2	500
1,978	" " . . .	74.4	3.0	1.0	11.6	7.8	2.2	460
	Average (8),	66.7	2.6	1.0	15.9	11.4	2.4	600
	Average all analyses (22),	69.8	2.6	1.0	14.0	10.3	2.3	545
1,852	Orchard grass, . . .	64.1	2.8	1.1	16.9	12.1	3.0	640
1,963	" " . . .	68.9	1.9	1.1	15.0	11.7	2.1	565
1,851	" " . . .	62.8	2.5	1.1	16.5	13.9	3.2	660
1,964	" " . . .	68.9	2.0	1.0	14.5	11.2	2.4	555
1,853	" " . . .	68.8	2.7	.9	14.3	10.5	2.8	550
1,965	" " . . .	73.3	2.2	1.0	12.1	8.9	2.5	475
1,854	" " . . .	70.3	3.9	1.2	11.8	10.2	2.6	530
1,966	" " . . .	77.2	2.5	.9	9.9	7.5	2.0	410
	Average (8),	69.3	2.5	1.0	13.9	10.7	2.6	545
	Average all analyses (24),	68.9	2.8	1.2	13.7	10.7	2.7	555
1,860	Red top, . . .	48.8	3.6	1.7	26.5	16.0	3.4	930
1,859	" " . . .	57.5	2.8	1.4	21.7	13.5	3.1	765
1,861	" " . . .	53.8	2.9	1.4	25.4	13.9	2.6	845
1,862	" " . . .	56.6	3.9	1.3	22.7	13.1	2.4	795
	Average (4),	54.2	3.3	1.4	24.1	14.1	2.9	830
	Average all analyses (8),	57.1	3.2	1.4	22.6	12.9	2.8	780
1,848	Timothy, . . .	60.0	2.4	1.1	19.5	15.0	2.0	735
1,971	" " . . .	60.2	3.0	1.2	19.9	13.6	2.1	730
1,847	" " . . .	61.1	2.4	1.2	20.3	12.7	2.3	710
1,972	" " . . .	62.1	2.5	1.1	18.6	13.4	2.3	685
1,849	" " . . .	64.4	2.0	1.0	17.7	13.0	1.9	650
1,973	" " . . .	63.9	2.7	1.0	16.2	14.1	2.1	655
1,850	" " . . .	64.7	2.6	1.1	16.4	13.0	2.2	640
1,974	" " . . .	63.8	3.3	1.2	17.5	12.3	1.9	665
	Average (8),	62.5	2.6	1.1	18.3	13.4	2.1	685
	Average all analyses (24),	66.6	2.6	1.0	16.3	11.5	2.0	605
1,872	Cow pea fodder, . . .	81.5	4.0	.8	6.9	4.3	2.5	315
1,880	" " . . .	81.1	3.4	.6	8.3	4.4	2.2	325
6,002	" " . . .	81.1	3.1	.6	9.2	4.3	1.7	335
6,003	" " . . .	81.1	3.4	.6	8.7	4.1	2.1	325

TABLE 46.—CONTINUED.

Laboratory No.	Feeding stuffs.	Water.	Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.	Fuel value per pound.
	<i>Green fodders.</i>	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Calories.
1,871	Cow pea fodder, . . .	83.8	3.1	.5	7.3	3.6	1.7	280
1,876	" " . . .	83.2	3.0	.4	7.3	4.3	1.8	290
6,004	" " . . .	82.7	3.1	.5	7.9	4.2	1.6	305
6,005	" " . . .	84.1	3.1	.4	6.7	4.0	1.7	275
1,879	" " . . .	82.2	3.2	.5	7.8	4.5	1.8	310
6,006	" " . . .	81.9	3.0	.5	8.8	4.4	1.4	320
1,878	" " . . .	82.2	3.4	.5	8.0	4.1	1.8	310
6,007	" " . . .	82.5	3.0	.6	8.0	4.5	1.4	315
1,877	" " . . .	82.9	3.1	.4	7.5	4.3	1.8	295
6,008	" " . . .	81.4	3.3	.7	8.9	4.2	1.5	335
1,875	" " . . .	83.5	3.1	.5	7.1	3.9	1.9	285
6,009	" " . . .	82.1	3.0	.6	8.1	4.5	1.7	315
1,874	" " . . .	82.8	2.7	.6	8.1	3.9	1.9	300
6,010	" " . . .	83.0	3.1	.4	7.5	4.3	1.7	295
1,873	" " . . .	82.0	4.1	.6	7.1	4.2	2.0	310
6,011	" " . . .	83.2	2.9	.5	7.8	3.9	1.7	295
	Average (20),	82.4	3.2	.5	7.9	4.2	1.8	305
	Average all analyses (67),	82.8	3.1	.6	7.7	3.9	1.9	300
1,913	Barley and pea fodder, . . .	75.4	4.0	1.0	12.1	5.7	1.8	450
1,914	" " . . .	74.1	4.0	.9	12.7	6.2	2.1	465
	Average (2),	74.7	4.0	1.0	12.4	5.9	2.0	455
	Average all analyses (9),	79.4	3.7	.8	9.1	5.2	1.8	370
1,915	Barley fodder, . . .	73.0	3.1	.8	15.1	6.0	2.0	485
1,916	" " . . .	71.3	3.2	.9	16.0	6.6	2.0	520
	Average (2),	72.1	3.2	.9	15.5	6.3	2.0	505
	Average all analyses (6),	75.2	3.4	.9	12.0	6.5	2.0	445
1,881	Oat and pea fodder, . . .	74.4	2.8	1.0	12.0	7.9	1.9	465
1,882	" " . . .	74.3	3.2	.9	11.7	7.8	2.1	460
	Average (2),	74.3	3.0	1.0	11.8	7.9	2.0	465
	Average all analyses (9),	78.7	3.5	1.0	9.1	6.0	1.7	390
1,883	Soy bean fodder, . . .	77.0	3.4	.7	10.4	6.3	2.2	405
1,884	" " . . .	76.4	3.7	.7	11.0	6.1	2.1	415
6,001	" " . . .	73.2	5.3	2.3	9.3	7.8	2.1	515
	Average (3),	75.6	4.1	1.2	10.3	6.7	2.1	445
	Average all analyses (16),	76.3	3.7	1.0	10.2	6.5	2.3	420
1,885	Sweet corn fodder, . . .	78.5	1.9	.6	14.1	3.7	1.2	390
1,886	" " . . .	76.6	1.7	.7	16.2	3.6	1.2	430
	Average (2),	77.5	1.8	.7	15.1	3.7	1.2	410
	Average all analyses (8),	80.0	1.8	.6	12.3	4.1	1.2	365
2,000	Ensilage corn, . . .	72.1	2.5	.8	17.1	5.9	1.6	510
	<i>Ensilage.</i>							
1,922	Corn ensilage, . . .	79.1	1.7	.6	10.4	7.1	1.1	380
1,927	" " . . .	79.5	1.7	.6	10.0	6.8	1.4	370
1,980	" " . . .	66.4	3.0	1.3	22.1	5.7	1.5	630
	Average (3),	75.0	2.1	.8	14.2	6.6	1.3	460
	Average all analyses (21),	74.7	2.0	.9	14.8	6.2	1.4	465

TABLE 46.—CONTINUED.

Laboratory No.	Feeding stuffs.	Water.	Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.	Fuel value per pound.
	<i>Cured fodders and hays.</i>	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Calories.
1,979	Corn stover,	27.1	4.9	1.4	36.1	23.7	6.8	1,260
1,983	" "	13.9	5.9	2.7	46.3	23.5	7.7	1,520
	Average (2),	20.5	5.4	2.0	41.2	23.6	7.3	1,390
	Average all analyses (180),	40.8	3.7	1.2	30.2	20.3	3.8	1,060
1,921	Hay, clover rowen, . .	16.4	11.8	2.5	34.4	29.4	5.5	1,510
1,933	Hay, clover, X grasses, .	8.5	13.5	3.0	42.3	26.2	6.5	1,650
	Average (2),	12.5	12.6	2.8	38.3	27.8	6.0	1,580
	Average all analyses (8),	11.5	14.8	3.3	38.9	24.9	6.6	1,600
1,984	Hay, Hungarian, . . .	7.8	6.6	4.3	51.6	23.5	6.2	1,700
1,985	" "	7.5	6.9	4.4	50.5	24.2	6.5	1,705
1,986	" "	7.0	6.9	3.7	51.2	24.7	6.5	1,695
1,987	" "	7.9	7.1	3.6	51.6	23.5	6.3	1,680
1,988	" "	6.5	8.7	4.1	55.3	20.5	4.9	1,745
1,989	" "	6.6	8.8	4.0	54.5	21.2	4.9	1,740
1,990	" "	6.2	8.4	4.3	54.0	22.3	4.8	1,755
1,991	" "	5.7	8.4	4.0	52.4	24.5	5.0	1,755
1,992	" "	6.3	10.4	4.3	51.9	21.6	5.5	1,745
1,993	" "	5.7	11.6	4.0	51.5	21.8	5.4	1,750
1,994	" "	5.8	11.1	4.0	51.7	21.6	5.8	1,740
1,995	" "	5.5	11.6	3.7	51.7	21.7	5.8	1,740
1,996	" "	5.1	13.1	4.1	48.9	22.5	6.3	1,745
1,997	" "	5.4	12.1	3.9	50.3	22.1	6.2	1,735
1,998	" "	5.8	12.0	4.0	50.2	22.1	5.9	1,735
1,999	" "	5.8	11.3	4.0	50.4	22.6	5.9	1,735
	Average (16),	6.3	9.7	4.0	51.7	22.5	5.8	1,730
	Average all analyses (33),	16.5	8.2	3.2	43.9	22.6	5.6	1,525
1,926	Hay, mixed grasses, . .	8.8	6.1	2.3	45.4	33.1	4.3	1,670
1,932	" "	15.6	9.8	2.3	36.0	31.2	5.1	1,530
1,934	" "	8.9	8.3	2.3	47.3	28.9	4.3	1,670
1,937	" "	8.8	11.4	2.6	40.8	30.7	5.7	1,650
1,938	" "	6.6	13.7	2.9	40.2	29.4	7.2	1,670
1,939	" "	5.6	12.3	2.7	42.6	30.7	6.1	1,705
	Average (6),	9.0	10.3	2.5	42.1	30.7	5.4	1,650
	Average all analyses (42),	11.7	8.1	2.9	43.8	28.1	5.4	1,610
1,940	Hay, fine rowen, . . .	12.0	15.3	3.5	37.7	25.1	6.4	1,600
1,942	" "	11.5	15.3	3.3	37.6	25.7	6.6	1,600
1,943	" "	10.7	16.0	3.8	31.9	30.6	7.0	1,620
1,981	" "	10.2	12.3	3.5	41.4	24.9	7.7	1,610
1,982	" "	6.7	13.4	4.2	41.0	27.3	7.4	1,695
	Average (5),	10.2	14.5	3.7	37.9	26.7	7.0	1,665
	Average all analyses (15),	13.1	14.0	3.7	38.3	24.4	6.5	1,585
1,931	Hay, second quality, . .	13.8	11.0	2.6	34.8	32.0	5.8	1,555
	Average all analyses (5),	12.4	9.3	2.9	41.7	28.1	5.6	1,595
	<i>Milling and by-products.</i>							
1,928	Chicago gluten meal, . .	9.1	38.1	2.7	46.9	2.1	1.1	1,735
1,960	" "	8.3	36.9	3.7	48.1	1.9	1.1	1,775
1,961	" "	9.5	36.7	3.8	47.2	1.7	1.1	1,755
	Average (3),	9.0	37.2	3.4	47.4	1.9	1.1	1,755
	Average all analyses (13),	8.8	36.6	5.8	45.3	2.5	1.0	1,815

TABLE 46.—CONTINUED.

Laboratory No.	Feeding stuffs.	Water.	Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.	Fuel value per pound.
		Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Calories.
1,935	<i>Milling and by-products.</i> Cleveland flax meal, . . .	9.2	38.4	2.6	33.1	12.3	4.4	1,670
1,925	Cottonseed meal, . . .	8.9	45.1	11.5	20.7	6.9	6.9	1,835
1,929	" " . . .	6.9	48.2	14.4	16.8	7.3	6.4	1,955
1,936	" " . . .	7.0	52.0	11.3	18.2	5.6	5.9	1,885
1,957	" " . . .	6.6	48.4	11.7	21.7	5.0	6.6	1,890
1,962	" " . . .	8.2	47.6	10.8	21.8	5.0	6.6	1,840
	Average (5),	7.5	48.3	11.9	19.8	6.0	6.5	1,880
	Average all analyses (21),	7.0	44.4	11.8	25.8	4.3	6.7	1,885
1,924	Quaker oat feed, . . .	6.7	13.5	4.2	56.9	13.3	5.4	1,735
1,944	" " . . .	7.9	9.2	2.2	54.5	20.7	5.5	1,660
	Average (2),	7.3	11.4	3.2	55.7	17.0	5.4	1,700
1,923	Wheat bran, . . .	7.7	16.2	4.8	52.8	11.4	7.1	1,700
1,930	" " . . .	9.5	20.1	4.7	48.9	10.5	6.3	1,675
1,958	" " . . .	11.1	15.5	4.6	50.9	10.9	7.0	1,630
1,959	" " . . .	11.2	15.7	4.2	50.6	11.6	6.7	1,625
	Average (4),	9.9	16.8	4.6	50.8	11.1	6.8	1,660
	Average all analyses (46),	9.7	17.0	5.0	53.3	9.4	5.6	1,695
1,836	Soy beans, . . .	5.5	36.0	17.2	28.4	8.3	4.6	2,075
1,837	" " . . .	5.0	35.4	16.0	35.3	3.9	4.4	2,060
6,012	" " . . .	6.8	41.2	17.9	25.3	3.7	5.1	2,060
6,013	" " . . .	8.4	41.8	18.2	23.3	3.3	5.0	2,040
1,838	" " . . .	4.9	36.4	17.0	32.4	4.2	5.1	2,075
1,839	" " . . .	4.5	36.8	16.9	32.3	4.3	5.2	2,080
6,014	" " . . .	8.2	38.8	19.4	25.2	3.1	5.3	2,065
6,015	" " . . .	9.4	38.6	19.5	24.4	2.9	5.2	2,050
1,840	" " . . .	3.7	36.2	17.5	33.0	4.5	5.1	2,110
6,016	" " . . .	9.1	40.8	19.2	23.5	2.2	5.2	2,045
1,841	" " . . .	3.6	36.6	17.6	29.9	6.6	5.7	2,100
6,017	" " . . .	8.6	40.9	18.6	24.6	2.3	5.0	2,045
1,842	" " . . .	3.8	36.6	18.2	31.7	4.5	5.2	2,120
6,018	" " . . .	9.0	40.4	18.9	23.9	2.7	5.1	2,045
1,843	" " . . .	2.8	40.3	17.9	29.5	4.4	5.1	2,135
6,019	" " . . .	9.3	37.8	19.4	25.4	3.2	4.9	2,055
1,844	" " . . .	3.7	40.4	17.5	29.0	4.3	5.1	2,110
6,020	" " . . .	9.5	38.5	19.8	24.5	2.6	5.1	2,055
1,845	" " . . .	4.6	40.2	17.2	28.0	4.5	5.5	2,075
6,021	" " . . .	9.3	38.1	19.7	24.3	3.1	5.5	2,050
	Average (20),	6.5	38.6	18.2	27.7	3.9	5.1	2,075
	Average all analyses (35),	8.3	36.8	18.4	27.2	3.7	5.6	2,035
1,846	Four o'clock seed, . . .	12.4	13.9	3.2	48.6	17.7	4.2	1,625

TABLE 47.—*Composition of water-free substance of fodders and feeding stuffs analyzed 1897-98.*

Laboratory No.	Feeding stuffs.	Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.	Fuel value per pound.
	<i>Green fodders.</i>	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Calories.
1,967	Bromus inermis, . . .	8.24	3.24	49.05	31.94	7.53	1,795
1,968	" " . . .	8.24	3.31	49.35	30.86	8.24	1,785
1,969	" " . . .	8.05	3.27	49.51	31.94	7.23	1,800
1,970	" " . . .	12.56	3.87	43.16	32.74	7.67	1,810
	Average (4),	9.27	3.42	47.77	31.87	7.67	1,800
	Average all analyses (8),	9.50	3.54	48.79	30.38	7.79	1,800
1,856	Meadow fescue, . . .	6.30	2.57	44.17	40.24	6.72	1,795
1,975	" " . . .	6.75	2.53	52.79	31.60	6.33	1,800
1,855	" " . . .	5.99	2.52	48.03	35.74	7.72	1,775
1,976	" " . . .	6.85	2.68	49.29	33.58	7.60	1,780
1,857	" " . . .	7.85	2.89	46.69	35.40	7.17	1,795
1,977	" " . . .	7.03	3.01	50.29	32.58	7.09	1,800
1,858	" " . . .	11.89	3.69	42.97	33.59	7.86	1,800
1,978	" " . . .	11.80	4.12	45.30	30.27	8.51	1,795
	Average (8),	8.06	3.00	47.44	34.12	7.38	1,795
	Average all analyses (22),	8.67	3.19	46.09	34.48	7.57	1,795
1,852	Orchard grass, . . .	7.90	2.99	46.98	33.87	8.26	1,780
1,963	" " . . .	6.24	3.40	48.31	35.31	6.74	1,815
1,851	" " . . .	6.83	2.90	44.32	37.31	8.64	1,765
1,964	" " . . .	6.38	3.10	46.63	35.96	7.93	1,785
1,853	" " . . .	8.78	2.80	45.74	33.83	8.85	1,760
1,965	" " . . .	8.17	3.62	45.44	33.56	9.21	1,775
1,854	" " . . .	13.01	3.89	39.80	34.41	8.89	1,785
1,966	" " . . .	11.02	4.08	43.46	32.85	8.59	1,795
	Average (8),	8.54	3.34	45.08	34.64	8.40	1,785
	Average all analyses (24),	9.34	3.95	43.85	34.16	8.70	1,790
1,860	Red top, . . .	7.08	3.21	51.79	31.32	6.60	1,815
1,859	" " . . .	6.58	3.29	50.97	31.78	7.38	1,800
1,861	" " . . .	6.33	3.04	54.95	29.99	5.69	1,825
1,862	" " . . .	9.13	2.92	52.23	30.19	5.53	1,825
	Average (4),	7.28	3.12	52.48	30.82	6.30	1,815
	Average all analyses (8),	7.56	3.28	52.62	30.05	6.49	1,815
1,848	Timothy, . . .	5.93	2.78	48.81	37.51	4.97	1,835
1,971	" " . . .	7.57	3.14	49.93	34.17	5.19	1,840
1,847	" " . . .	6.26	3.03	52.12	32.77	5.82	1,820
1,972	" " . . .	6.71	2.83	49.09	35.29	6.08	1,810
1,849	" " . . .	5.64	2.81	49.82	36.46	5.27	1,825
1,973	" " . . .	7.48	2.80	44.92	38.97	5.83	1,815
1,850	" " . . .	7.26	2.97	46.52	37.00	6.25	1,815
1,974	" " . . .	9.07	3.30	48.27	34.02	5.34	1,840
	Average (8),	6.99	2.96	48.69	35.77	5.59	1,825
	Average all analyses (24),	7.83	3.14	48.66	34.33	6.04	1,820
1,872	Cow pea fodder, . . .	21.69	4.14	37.37	23.35	13.45	1,705
1,880	" " . . .	18.13	3.03	44.02	23.46	11.36	1,720
6,002	" " . . .	16.26	3.17	48.52	22.99	9.06	1,765
6,003	" " . . .	17.87	3.40	46.18	21.64	10.91	1,740

TABLE 47.—CONTINUED.

Laboratory No.	Feeding stuffs.	Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.	Fuel value per pound.
	<i>Green fodders.</i>	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Calories.
1,871	Cow pea fodder, . . .	19.25	3.12	44.77	22.24	10.62	1,735
1,876	" " . . .	18.17	2.49	43.33	25.37	10.64	1,720
6,004	" " . . .	17.98	2.91	45.50	24.50	9.11	1,760
6,005	" " . . .	19.57	2.66	41.97	25.45	10.35	1,730
1,879	" " . . .	17.68	2.86	43.82	25.38	10.26	1,735
6,006	" " . . .	16.38	2.85	48.35	24.49	7.93	1,780
1,878	" " . . .	19.03	2.64	45.33	22.87	10.13	1,735
6,007	" " . . .	16.91	3.41	45.66	25.94	8.08	1,790
1,877	" " . . .	18.43	2.55	43.72	24.95	10.35	1,725
6,008	" " . . .	17.51	3.53	48.15	22.57	8.24	1,790
1,875	" " . . .	18.43	2.99	43.13	23.94	11.51	1,715
6,009	" " . . .	16.82	3.16	45.26	25.15	9.61	1,755
1,874	" " . . .	15.91	3.63	47.08	22.49	10.89	1,745
6,010	" " . . .	17.99	2.60	44.10	25.25	10.06	1,735
1,873	" " . . .	22.79	3.37	39.35	23.34	11.15	1,730
6,011	" " . . .	17.03	2.77	46.54	23.39	10.27	1,735
	Average (20),	18.19	3.06	44.61	23.94	10.20	1,745
	Average all analyses (67),	18.12	3.36	44.64	22.74	11.14	1,730
1,913	Barley and pea fodder, . .	16.43	3.87	49.31	23.08	7.31	1,815
1,914	" " . . .	15.50	3.68	49.06	23.71	8.05	1,800
	Average (2),	15.97	3.78	49.18	23.39	7.68	1,805
	Average all analyses (9),	18.32	3.99	43.78	24.92	8.99	1,785
1,915	Barley fodder, . . .	11.68	2.97	55.75	22.31	7.29	1,795
1,916	" " . . .	11.28	2.95	55.78	22.99	7.00	1,800
	Average (2),	11.48	2.96	55.77	22.65	7.14	1,795
	Average all analyses (6),	14.03	3.55	47.97	26.27	8.18	1,790
1,881	Oat and pea fodder, . . .	11.02	3.68	46.82	30.92	7.56	1,805
1,882	" " . . .	12.59	3.55	45.43	30.43	8.00	1,795
	Average (2),	11.80	3.61	46.13	30.68	7.78	1,800
	Average all analyses (9),	17.34	4.70	41.84	27.57	8.55	1,815
1,883	Soy bean fodder, . . .	14.96	2.94	45.27	27.48	9.35	1,755
1,884	" " . . .	15.67	3.01	46.65	25.87	8.80	1,770
6,001	" " . . .	19.83	8.42	34.52	29.25	7.98	1,910
	Average (3),	16.82	4.79	42.15	27.53	8.71	1,810
	Average all analyses (16),	15.55	4.22	42.87	27.57	9.79	1,775
1,885	Sweet corn fodder, . . .	8.65	2.88	65.78	17.12	5.57	1,825
1,886	" " . . .	7.43	3.03	69.28	15.22	5.04	1,835
	Average (2),	8.04	2.95	67.53	16.17	5.31	1,830
	Average all analyses (8),	9.03	2.87	61.37	20.78	5.95	1,815
2,000	Ensilage corn, . . .	8.99	2.67	61.26	21.35	5.73	1,815
	<i>Ensilage.</i>						
1,922	Corn ensilage, . . .	8.16	2.89	49.50	34.12	5.33	1,830
1,927	" " . . .	8.24	2.93	48.74	32.97	7.12	1,795
1,980	" " . . .	9.07	3.79	65.70	16.91	4.53	1,865
	Average (3),	8.49	3.20	54.65	28.00	5.66	1,830
	Average all analyses (21),	8.05	3.51	56.89	25.80	5.75	1,835

TABLE 47.—CONTINUED.

Laboratory No.	Feeding stuffs.	Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.	Fuel value per pound.
	<i>Cured fodders and hays.</i>	Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Calories.
1,979	Corn stover,	6.68	1.87	49.57	32.57	9.31	1,730
1,983	" "	6.86	3.14	53.83	27.25	8.92	1,770
	Average (2),	6.77	2.50	51.70	29.91	9.12	1,750
	Average all analyses (180),	6.39	1.98	51.00	34.20	6.43	1,785
1,921	Hay, clover rowen, . .	14.17	2.99	41.10	35.17	6.57	1,810
1,933	Hay, clover, $\frac{1}{2}$ grasses, .	14.69	3.31	46.22	28.64	7.14	1,805
	Average (2),	14.43	3.15	43.66	31.90	6.86	1,805
	Average all analyses (8),	16.77	3.72	43.90	28.17	7.44	1,810
1,984	Hay, Hungarian, . . .	7.12	4.69	55.93	25.53	6.73	1,845
1,985	" "	7.42	4.76	54.05	26.15	7.02	1,840
1,986	" "	7.46	4.01	54.99	26.53	7.01	1,825
1,987	" "	7.67	3.95	56.05	25.54	6.79	1,825
1,988	" "	9.36	4.34	59.10	21.90	5.30	1,865
1,989	" "	9.37	4.32	58.38	22.65	5.28	1,865
1,990	" "	9.00	4.56	57.56	23.72	5.16	1,870
1,991	" "	8.95	4.22	55.57	25.98	5.28	1,860
1,992	" "	11.14	4.58	55.34	23.04	5.90	1,855
1,993	" "	12.26	4.22	54.66	23.07	5.79	1,850
1,994	" "	11.74	4.21	54.92	22.96	6.17	1,845
1,995	" "	12.24	3.91	54.73	22.97	6.15	1,840
1,996	" "	13.84	4.32	51.50	23.70	6.64	1,840
1,997	" "	12.82	4.17	53.17	23.31	6.53	1,835
1,998	" "	12.74	4.25	53.33	23.45	6.23	1,845
1,999	" "	12.00	4.28	53.47	23.95	6.30	1,845
	Average (16),	10.32	4.30	55.21	24.03	6.14	1,845
	Average all analyses (33),	9.90	3.73	52.10	27.43	6.84	1,820
1,926	Hay, mixed grasses, . .	6.63	2.51	49.83	36.30	4.73	1,830
1,932	" "	11.66	2.77	42.65	36.93	5.99	1,815
1,934	" "	9.12	2.47	51.91	31.73	4.77	1,830
1,937	" "	12.48	2.87	44.78	33.62	6.25	1,810
1,938	" "	14.63	3.13	42.99	31.51	7.74	1,790
1,939	" "	12.06	2.86	45.14	32.54	6.50	1,805
	Average (6),	11.25	2.77	46.21	33.77	6.00	1,815
	Average all analyses (42),	9.14	3.30	49.63	31.87	6.06	1,825
1,940	Hay, fine rowen, . . .	17.37	3.96	42.81	28.52	7.34	1,815
1,942	" "	17.31	3.68	42.48	29.05	7.48	1,810
1,943	" "	17.93	4.21	35.72	24.25	7.80	1,810
1,981	" "	13.71	3.90	46.14	27.68	8.57	1,790
1,982	" "	14.32	4.47	43.92	20.31	7.98	1,815
	Average (5),	16.13	4.04	42.22	29.76	7.85	1,810
	Average all analyses (15),	16.19	4.24	44.10	28.02	7.45	1,820
1,931	Hay, second quality, .	12.78	3.05	40.41	37.09	6.67	1,810
	Average all analyses (5),	10.58	3.29	47.58	32.06	6.49	1,820
	<i>Milling and by-products.</i>						
1,928	Chicago gluten meal, . .	41.97	2.97	51.62	2.29	1.15	1,910
1,960	" "	40.22	4.02	52.47	2.10	1.19	1,930
1,961	" "	40.55	4.24	52.20	1.85	1.16	1,935
	Average (3),	40.91	3.74	52.10	2.08	1.17	1,930
	Average all analyses (13),	40.18	6.29	49.70	2.73	1.10	1,990

TABLE 47.—CONTINUED.

Laboratory No.	Feeding stuffs.	Protein.	Fat.	Nitrogen free extract.	Fiber.	Ash.	Fuel value per pound.
		Per ct.	Per ct.	Per ct.	Per ct.	Per ct.	Calories.
1,935	<i>Milling and by-products.</i> Cleveland flax meal, . . .	42.35	2.90	36.45	13.51	4.79	1,840
1,925	Cottonseed meal, . . .	49.49	12.64	22.71	7.54	7.62	2,015
1,929	" " . . .	51.75	15.49	18.5	7.84	6.87	2,100
1,936	" " . . .	55.93	12.10	19.58	6.06	6.33	2,025
1,957	" " . . .	51.82	12.51	23.24	5.40	7.03	2,025
1,962	" " . . .	51.82	11.71	23.72	5.50	7.25	2,000
	Average (5),	52.16	12.89	21.46	6.47	7.02	2,035
	Average all analyses (21),	47.72	12.65	27.75	4.62	7.26	2,025
1,924	Quaker oat feed, . . .	14.47	4.47	61.01	14.28	5.77	1,860
1,944	" " . . .	10.00	2.30	59.20	22.50	6.00	1,805
	Average (2),	12.23	3.38	60.11	18.39	5.89	1,830
1,923	Wheat bran, . . .	17.53	5.24	57.14	12.37	7.72	1,840
1,930	" " . . .	22.22	5.20	54.03	11.57	6.98	1,850
1,958	" " . . .	17.43	5.20	57.25	12.22	7.90	1,835
1,959	" " . . .	17.68	4.77	56.99	13.00	7.56	1,830
	Average (4),	18.72	5.10	56.35	12.29	7.54	1,840
	Average all analyses (40),	18.80	5.58	59.04	10.37	6.21	1,875
1,836	Soy beans, . . .	38.14	18.16	30.07	8.75	4.88	2,195
1,837	" " . . .	37.27	16.81	37.20	4.14	4.58	2,170
6,012	" " . . .	44.21	19.21	27.15	4.00	5.43	2,210
6,013	" " . . .	45.65	19.86	25.43	3.62	5.44	2,225
1,838	" " . . .	38.32	17.88	34.07	4.38	5.35	2,180
1,839	" " . . .	38.55	17.66	33.86	4.52	5.41	2,175
6,014	" " . . .	42.23	21.16	27.46	3.42	5.73	2,250
6,015	" " . . .	42.64	21.54	26.88	3.25	5.69	2,260
1,840	" " . . .	37.58	18.13	34.33	4.64	5.32	2,185
6,016	" " . . .	44.91	21.10	25.87	2.45	5.67	2,250
1,841	" " . . .	38.00	18.25	31.07	6.80	5.88	2,180
6,017	" " . . .	44.77	20.31	26.88	2.55	5.49	2,235
1,842	" " . . .	38.09	18.95	32.98	4.61	5.37	2,205
6,018	" " . . .	44.40	20.72	26.33	2.94	5.61	2,245
1,843	" " . . .	41.45	18.41	30.31	4.58	5.25	2,195
6,019	" " . . .	41.64	21.40	28.03	3.48	5.45	2,265
1,844	" " . . .	41.93	18.22	30.15	4.47	5.23	2,190
6,020	" " . . .	42.54	21.82	27.15	2.87	5.62	2,270
1,845	" " . . .	42.12	18.00	29.33	4.73	5.82	2,175
6,021	" " . . .	42.05	21.77	26.72	3.38	6.08	2,260
	Average (20),	41.32	19.47	29.56	4.18	5.47	2,215
	Average all analyses (35),	40.16	20.01	29.66	4.04	6.13	2,220
1,846	Four o'clock seed, . . .	15.92	3.66	55.48	20.19	4.75	1,860

METEOROLOGICAL OBSERVATIONS.

REPORTED BY C. S. PHELPS.

The meteorological observations made under the directions of the Station during 1898 were similar to those of previous years. The Station equipment at Storrs consists of the ordinary instruments for observing temperatures, pressure of the air, humidity, rainfall, snowfall, and velocity of the wind. The instruments are similar to those in use by the United States Weather Service. In addition to the records made at Storrs, the rainfall for the summer season (May 1st to October 31st) has been recorded by eleven farmers in co-operation with the Station.

The total precipitation for the year (51.1 inches) was 5.3 inches above the average at Storrs for the past ten years, and about 3 inches above the general average for Connecticut, as computed from the records of all of the New England Meteorological Society's observers who have made observations covering periods of from five to thirty years. The rainfall was fairly well distributed throughout the year. Early in the season there was sufficient rain to give all crops a vigorous start, while during July and August there was a slight excess, but, on the whole, the moisture in the soil was about right to keep up a healthy and vigorous growth of all crops.

The temperature for January and February was about normal. March was unusually mild, so that some garden truck was planted and oats were sown. The temperature for April and May was unusually low, and the spring as a whole was rather backward. The last killing frost occurred on May 10th. The summer months were unusually warm and the weather conditions were favorable for nearly all crops. The hay crop was a heavy one and nearly all early-cut fields produced a large second crop. Light frosts occurred on low grounds September 13th and 14th, and more generally on September 21st and October 10th and 13th, but the first killing frost was on October 17th. The length of the growing season from the last killing frost in the spring to the first killing frost in the fall was 160 days. The average growing season at Storrs for the past eleven years has been 147 days.

The month of October was too wet for harvesting corn, and in many places the crop was considerably damaged.

The most phenomenal storm of the season was the snow storm of November 26-27th, which gave about one foot of snow on a level and produced drifts of from six to eight feet deep. Roads were blocked for three days, greatly delaying travel.

Through the kindness of the New England Meteorological Society we are able to publish the rainfall records from ten of their stations in Connecticut. Table 48 gives the rainfall as recorded for the six months ending October 31st for twenty-one localities in the State, and Table 49 gives the summary of observations made by the Station at Storrs.

TABLE 48.—*Rainfall during six months ending October 31, 1898.*

Locality.	Observer.	INCHES PER MONTH.						
		May.	June.	July.	August.	September.	October.	Total.
Falls Village,	M. H. Dean,	6.35	2.99	2.23	8.22	3.73	3.74	27.26
Cream Hill,	C. L. Gold,	6.70	2.87	1.79	6.77	4.25	3.35	25.73
Winchester,	W. L. Wetmore,	4.45	2.40	2.92	6.90	2.80	4.40	23.87
Waterbury,	N. J. Welton,	6.86	.94	3.37	9.48	2.52	5.82	28.99
Norwalk,	G. C. Comstock,	8.53	.79	7.27	7.15	1.40	8.29	33.43
Southington,	Lumen Andrews,	5.56	.53	3.33	8.50	2.63	6.09	26.64
West Simsbury,	S. T. Stockwell,	6.18	2.23	4.59	7.38	2.07	4.99	27.44
Canton,	G. J. Case,	6.74	2.71	4.97	7.02	2.31	5.44	29.19
Hartford,	Prof. S. Hart,	6.05	2.40	5.15	7.58	2.86	6.32	30.36
Newington,	J. S. Kirkham,	6.23	1.35	3.66	6.18	3.41	4.59	25.42
New Haven,	Weather Bureau,	8.03	.21	5.03	6.55	2.30	7.22	29.34
Madison,	J. D. Kelsey,	8.12	.99	5.47	8.66	2.88	7.19	33.31
South Manchester,	K. B. Loomis,	5.53	1.48	5.78	6.68	2.83	6.91	29.21
New London,	Weather Bureau,	8.12	1.09	4.72	7.69	3.33	8.47	33.42
Colchester,	S. P. Willard,	6.16	.79	5.05	8.65	2.61	6.39	29.65
Gilead,	A. C. Gilbert,	5.86	1.58	4.97	8.02	2.81	5.94	29.18
Lebanon,	E. A. Hoxie,	6.08	2.40	7.28	8.40	1.85	5.25	31.26
North Franklin,	C. H. Lathrop,	6.23	1.89	6.84	7.69	3.22	6.21	32.08
Storrs,	Experiment Sta.,	3.81	2.48	6.24	5.87	2.22	6.18	26.80
Voluntown,	Rev. C. Dewhurst,	6.45	3.44	5.73	7.28	2.65	9.33	34.88
Clark's Falls,	E. D. Chapman,	5.15	1.25	6.67	6.66	2.11	11.01	32.85
Average,		6.34	1.75	4.91	7.49	2.71	6.34	29.54

TABLE 49.—*Meteorological summary for 1898.*

[Observations made at Storrs, by the Station.]

	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Mean.	Total.
Highest barometer, .	30.58	30.63	30.77	30.33	30.36	30.33	30.45	30.26	30.43	30.48	30.54	30.54	30.48	.....
Lowest barometer, .	29.29	29.06	29.86	29.52	29.65	29.50	29.72	29.75	29.69	29.44	29.25	29.32	29.50	.....
Mean barometer, .	30.00	30.07	30.23	29.95	29.98	30.00	30.05	30.00	30.06	30.12	30.03	30.04	30.04	.....
Highest temperature, .	51	51	62	70	81	87	90	88	90	85	61	53	73	.....
Lowest temperature, .	-7	-4	19	16	33	44	45	47	37	29	15	-4	23	.....
Mean temperature, .	25	28	40	42	54	64	70	69	63	52	38	29	48	.....
Relative humidity, .	.....	.....	.....	68	76	75	79	53	79	83	.....	.....	.....	.....
Total precipitation, .	4.70	4.03	3.09	4.44	3.81	2.48	6.24	5.87	2.22	6.18	6.11	1.96	.....	51.13
No. of days with precipita- tion of .01 inch or more, .	12	9	11	12	17	6	9	13	8	10	9	7	.....	123
No. of clear days, .	5	10	10	8	6	6	6	6	14	10	9	6	.....	99
No. of fair days, .	11	6	9	10	6	18	18	17	8	11	9	14	.....	138
No. of cloudy days, .	15	12	12	12	16	6	6	8	8	10	12	11	.....	128
Total movement of wind in miles, .	8,492	6,665	5,785	8,057	6,099	5,978	4,269	4,924	4,981	6,351	7,556	6,909	76,066
Maximum velocity of wind, .	48	60	36	36	39	30	45	40	36	42	54	60

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CORRECTIONS.

- Page 17. Eighth line from the bottom, after *than* insert $\frac{1}{12}$.
- Page 36. Ninth line from top, for 10596 read 10569.
- Page 40. In the fourteenth line from the bottom, for *good* read *food*.
- Page 73. The guaranteed percentage of potash in Chittenden's potato phosphate No. 10355 is *eight* per cent. not *ten* per cent. as given in the table.
- Page 124. For W. F. Wackley, Middletown, read W. F. Ackley.
- Page 220. In the heading and also in second line under Vinegar, for 1897 read 1898.

STATE OF CONNECTICUT

TWENTY-SECOND ANNUAL REPORT
OF
The Connecticut Agricultural
Experiment Station
FOR 1898.

Printed by Order of the General Assembly

The publications of this Station are sent free to every citizen of
Connecticut who applies for them. Address, The Conn.
Agricultural Experiment Station, New Haven, Conn.

HARTFORD, CONN.
PRESS OF THE CASE, LOCKWOOD & BRAINARD COMPANY.
1899.

CONNECTICUT AGRICULTURAL EXPERIMENT STATION.

OFFICERS AND STAFF FOR 1898.

STATE BOARD OF CONTROL.

Ex officio.

HIS EXCELLENCY LORRIN A. COOKE, *President.*

<i>Appointed by Connecticut State Agricultural Society :</i>	Term expires.
S. M. WELLS, Wethersfield.	July 1, 1900

<i>Appointed by Board of Trustees of Wesleyan University :</i>	
PROF. W. O. ATWATER, Middletown.	1900

<i>Appointed by Governor and Senate :</i>	
EDWIN HOYT, New Canaan.	1901
JAMES H. WEBB, Hamden.	1899

<i>Appointed by Board of Agriculture :</i>	
T. S. GOLD, West Cornwall, <i>Vice-President.</i>	1901

<i>Executive Committee.</i>	<i>Appointed by Governing Board of Sheffield Scientific School :</i>	
	W. H. BREWER, New Haven, <i>Secretary and Treasurer.</i>	1899

<i>Ex officio.</i>
S. W. JOHNSON, New Haven, <i>Director.</i>

STATION STAFF.

Chemists.

S. W. JOHNSON, <i>Director.</i>	T. B. OSBORNE, PH.D.
E. H. JENKINS, PH.D., <i>Vice-Dir.</i>	A. W. OGDEN, PH.B.
A. L. WINTON, PH.B.	G. F. CAMPBELL, PH.B.
W. L. MITCHELL, PH.B.	

Mycologist.

WILLIAM C. STURGIS, PH.D.

Horticulturist.

W. E. BRITTON, B.S.

Grass Gardener.

JAMES B. OLCOTT, South Manchester.

Stenographer and Clerk.

Miss V. E. COLE.

In charge of Buildings and Grounds.

CHARLES J. RICE.

Laboratory Helpers.

HUGO LANGE.	WILLIAM POKROB.
-------------	-----------------

Sampling Agent.

V. L. CHURCHILL, New Haven.

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ANNOUNCEMENT.

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION was established in accordance with an Act of the General Assembly approved March 21, 1877, "for the purpose of promoting Agriculture by scientific investigation and experiment."

The Station is prepared to analyze and test fertilizers, cattle-food, seeds, milk, and other agricultural materials and products, to identify grasses, weeds, moulds, blights, mildews, useful or injurious insects, etc., and to give information on various subjects of Agricultural Science, for the use and advantage of the citizens of Connecticut.

The Station does not undertake sanitary analyses of water.

The Station makes analyses of Fertilizers, Seed-Tests, etc., for the citizens of Connecticut, without charge, provided —

1. That the results are of use to the public and are free to publish.
2. That the samples are taken from stock now in the market, and in accordance with the Station "Instructions for Sampling."
3. That the samples are fully described and retail prices given on the Station "Forms for Description."

The officers of the Station will take pains to obtain for analysis samples of all the commercial fertilizers sold in Connecticut; but the organized coöperation of farmers is essential for the full and timely protection of their interests. Granges, Farmers' Clubs, and like associations can efficiently work with the Station for this purpose, by sending in duly authenticated samples early during each season of trade.


~~By~~ By a recent Act of Legislature it is made the business of this Station to examine articles of food and drink on sale in Connecticut, with reference to their adulterations.


Here it may be stated that, *until further notice*, the Station will examine only such samples of food and drink as are collected by its agents or such as shall be taken under its advice, and by the methods it shall prescribe or approve.


All other work proper to the Experiment Station that can be used for the public benefit will be done without charge. Work for the private use of individuals is charged for at moderate rates. The Station undertakes no work the results of which are not at its disposal to use or publish, if deemed advisable for the public good.

Results of analysis or investigation that are of immediate general interest are published in Bulletins, copies of which are sent to each Post Office in the State, and to every citizen of the State who applies for them. The results of all the work of the Station are summed up in the Annual Reports made to the Governor.

It is the wish of the Board of Control to make the Station as widely useful as its resources will admit. Every Connecticut citizen who is concerned in agriculture, whether farmer, manufacturer, or dealer, has the right to apply to the Station for any assistance that comes within its province to render, and the Station will respond to all applications as far as lies in its power.

 Instructions and Forms for taking samples, and Terms for testing Fertilizers, Seeds, etc., for private parties sent on application.


 Parcels by Express, to receive attention, should be *prepaid*.


 Letters sent to individual officers are liable to remain unanswered in case the officer addressed is absent. All communications therefore should be directed simply to the


AGRICULTURAL EXPERIMENT STATION,


NEW HAVEN, CONN.

and all remittances should be made payable to the undersigned.

 Station Grounds, Laboratories, and Office are on Huntington Street, five minutes walk west from Whitney Avenue and $1\frac{1}{8}$ miles north of City Hall.

 Huntington Street may be reached by Whitney Avenue Electric Cars, which leave the corner of Chapel and Church Streets five times hourly, viz.: on the striking of the clock and at intervals of twelve minutes thereafter.

 The Station has telephone connection and may be spoken from the Central Telephone Office, 118 Court Street, or from Peck & Bishop's Office in Union R.R. Depot, New Haven.

 The Grass Garden, in charge of Mr. James B. Olcott, is near South Manchester, five minutes walk from the line of the Manchester Electric Cars, leaving City Hall Square, State Street, Hartford, every half hour. Conductors on this line can direct visitors to the Garden.

S. W. JOHNSON, *Director*.

REPORT OF THE BOARD OF CONTROL.

To his Excellency, George E. Lounsbury, Governor of Connecticut:

The Board of Control of the Connecticut Agricultural Experiment Station herewith submits its Report for the year ending October 31st, 1898:

THE FERTILIZER CONTROL.

During the months of April, May, and June, Mr. V. L. Churchill, sampling agent of this Station, visited one hundred and twenty-nine towns and villages of Connecticut and drew seven hundred and seventy-six samples, representing two hundred and eighty-four of the two hundred and eighty-nine brands of commercial fertilizers which have been entered at the Station for sale in this State.

Analyses of samples of all these brands have been made in the chemical laboratory by Messrs. Winton, Ogden, and Mitchell, with the assistance of Mr. Lange.

A manuscript copy of each analysis has been sent to the manufacturers and to each dealer from whom a sample of the goods analyzed was taken.

The chemists named have also analyzed two hundred and eighty-five other samples of fertilizers and manurial waste products, making the total number of fertilizer analyses five hundred and sixty-nine.

A full account of the results of this work is given in Part I of the Report of the Station Staff.

EXAMINATION OF FOOD PRODUCTS.

One thousand and forty-eight samples of food products, the larger part of them bought by our sampling agent in open market, have been examined with reference to adulterants, by Messrs. Winton, Ogden, and Mitchell. A full account of this work and its results forms Part II of the Report of the Station Staff.

Nine samples of cattle foods have also been chemically and microscopically examined.

WORK FOR THE DAIRY COMMISSIONER.

All the chemical work required by the Dairy Commissioner has been done in the laboratory of this Station, including two hundred and three examinations of molasses, four of syrup, thirty-two of vinegar, seventeen of butter and imitation butter, and four of cream. Expert evidence has also been given in court when required.

OTHER CHEMICAL WORK.

In connection with work on the availability of different kinds of fertilizer-nitrogen, the chemists have made partial analyses of two hundred and twenty-one samples of turnips, Hungarian grass, red-top, and buckwheat; also fourteen samples of soil.

Considerable work has been done in the study of certain methods of quantitative analysis, which has included fifty determinations of nitrogen, forty-four of phosphoric acid, and thirty-six of potash, as well as a large number of determinations of nicotine, the alkaloid of tobacco.

STUDY OF PROTEIDS.

Dr. Osborne, with the assistance of Mr. Campbell, has made, during the year, an investigation of the proteids of wheat germs.

He has also devoted much labor to a closer study of several of the plant proteids described in former Annual Reports of this Station, and has taken up the investigation of egg-albumin.

It has been found that all proteid preparations contain small amounts of hydrochloric and sulphuric, or other acids, chemically combined to the proteid substance. Evidence has been obtained that *edestin*, for example, forms a series of definite compounds with acids, and the properties and composition of these compounds are being studied.

Some results of this work are ready for publication.

SEED TESTING.

Three hundred and thirty-three samples, chiefly of vegetable seeds, have been tested as to their vitality and germinative power, in the interests of seedsmen and purchasers.

MYCOLOGICAL WORK.

The investigations of Dr. Sturgis during the last Station year have included a study of three Diseases of Melons, viz.: "Wilt,"—a bacterial disease,—Black Mold, and Leaf Burn, with field experiments to test preventive measures; also field experiments on the prevention of the Mildew of Lima Beans; preliminary notes on the "Calico" and the Natural Spotting of Tobacco; and much miscellaneous work on questions referred to him by correspondents throughout the State.

On September first Dr. Sturgis went to Europe, having been given six months' leave of absence, for the purpose of further study in his special department.

HORTICULTURAL AND ENTOMOLOGICAL WORK.

The study of the relative availability of organic nitrogen in various forms has been continued by Dr. Jenkins and Mr. Britton, with the coöperation of the Station chemists. Sixty-two cultures of red-top grass, sixty-two of turnips, thirty of Hungarian grass, forty-eight of privet, and fourteen of buck-wheat have been made for this purpose, in galvanized iron pots charged with a natural soil, to which the several forms of nitrogenous plant-food had been added.

During the winter fifty comparative cultures of tomatoes, twelve of carnations, and ten of lettuce were made, on the one hand in rich compost, and on the other in a mixture of coal ashes, peat, and varying amounts of fertilizers. These cultures were made on the benches of the forcing houses to study the fertilizer requirements of these crops which are now grown extensively under glass.

Mr. Britton has also given attention to the grafting of chestnuts to determine the proper season and the best methods of setting chestnut cions in this State. Over two hundred cions were set at different times between April 20th and June 20th, in four separate places in and about New Haven.

The observations on the growth of forest-tree seedlings have been continued in coöperation with the Division of Forestry, U. S. Department of Agriculture.

In connection with the Section of Seed and Plant Introduction of the above-mentioned Department, forty-seven imported plants are being tested as to their value for cultivation in this country.

The Entomological work of the Station, which has considerably increased of late, has been done by Mr. Britton. Besides the correspondence and determination of insect species referred to the Station by correspondents, special attention has been given to a study of the San José scale; its present distribution in this State, its spread from infected places, and the effects of kerosene and other insecticides upon the scale, and also upon the trees to which they are applied.

Several States to which Connecticut nurserymen are shipping nursery stock have passed laws forbidding entry into those States of stock from nurseries which have not been inspected within the year, and requiring with each shipment a certificate of inspection. In response to requests from our nurserymen, Mr. Britton has made eleven inspections of nurseries, and in eight cases has given the desired certificate.

The method of banding trees to keep off canker worms, and the best substances to use on the bands, has also been studied.

FIELD EXPERIMENTS.

Under the supervision of Dr. Jenkins, the three experiments on the fertilization of peach orchards, begun in 1896, chiefly to study the effects of different amounts of potash salts and of the forms of nitrogen best adapted to the crop, have been continued, but the account of them is reserved until further data are secured.

TOBACCO EXPERIMENTS.

Under the direction of Dr. Jenkins, the curing of wrapper tobacco by artificial heat and the fermentation of this tobacco in bulk, instead of in case, have been studied during the year. For this purpose, a new experimental tobacco barn was built at Windsor to replace the one destroyed by fire last year.

STATION PUBLICATIONS.

The Twenty-first report of this Station, for the year 1897, a volume of 418 pages, has been issued in an edition of 7,000 copies. These have been distributed, after satisfying our exchanges, among the farmers of this State in response to applications.

Of the Second Annual Report on Food Products, 10,000 extra copies were printed at the expense of the Station, and

distributed in our cities and villages to intelligent citizens who are, presumably, interested in pure food but are not reached by the regular edition that is intended for the use of agriculturists.

Bulletin No. 125, issued in April last, sixteen pages, was entitled "Preparation and Application of Fungicides."

Bulletin No. 126, twelve pages, entitled "Insecticides; Their Preparation and Use," and Bulletin No. 127, ten pages, entitled "The Cast of Plant-Food in Connecticut, Spring Months of 1898," were issued in May, 1898.

Five thousand copies of each bulletin were printed and distributed.

Bulletins 125 and 126 are not reprinted in this Annual Report.

CORRESPONDENCE.

During the year three thousand two hundred and eighty-six letters and manuscript reports of fertilizer and other analyses have been written on Station business.

MEETINGS OF THE BOARD.

During the year ending October 31st the Board of Control has held three meetings.

All of which is respectfully submitted.

WM. H. BREWER, *Treasurer.*

REPORT OF THE TREASURER.

Wm. H. Brewer, in account with The Connecticut Agricultural Experiment Station for the fiscal year ending September 30, 1898.

RECEIPTS.

Balance from 1897,	\$3.14
State Appropriation, Agriculture,	10,000.00
State Appropriation, Food,	2,500.00
United States Appropriation,	7,500.00
Analysis Fees due 1897,	3,550.00
Analysis Fees due 1898,	3,095.00
Miscellaneous,	127.57
	—
	\$26,775.71

DISBURSEMENTS.

S. W. Johnson,	\$1,250.00
E. H. Jenkins,	2,500.00
W. H. Brewer,	433.32
V. E. Cole,	766.67
W. C. Sturgis,	2,000.00
T. B. Osborne,	1,700.00
A. L. Winton,	1,700.00
A. W. Ogden,	1,600.00
G. F. Campbell,	966.67
W. L. Mitchell,	825.00
H. Lange,	714.99
J. B. Olcott,	800.00
W. E. Britton,	1,100.00
C. J. Rice,	600.00
V. L. Churchill,	600.00
Labor,	911.60
Publications,	580.93
Postage,	155.77
Stationery,	235.47
Telephone and Telegraph,	117.77
Freight and Express,	78.88
Coal,	847.80
Gas,	357.50

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Water,	\$147.00	
Laboratory Supplies,	1,288.71	
Agricultural and Horticultural Supplies,	72.48	
Miscellaneous Supplies,	161.40	
Fertilizers,	102.39	
Feeding Stuffs,	100.37	
Library,	764.60	
Tools and Machinery,	77.10	
Furniture and Fixtures,	57.49	
Scientific Apparatus,	72.32	
Live Stock,	40.00	
Traveling Expenses of the Board,	60.91	
Traveling Expenses of the Staff,	156.64	
Tobacco Investigation,	1,501.13	
Fertilizer Sampling,	322.98	
Food Sampling,	244.65	
Unclassified Sundries,	20.25	
Repairs,	382.77	
Betterments,	78.77	\$26,494.33
Balance to New Account,		281.38
		<u>\$26,775.71</u>

Memorandum.—The accounts of the Treasurer have been duly audited by the State Auditors of Public Accounts, and the Report of the Treasurer for the fiscal year of the United States ending June 30, 1898, was duly rendered to the United States Secretary of the Treasury and the Secretary of Agriculture in July.

In the accounts as here written the disbursements for "Fertilizers" are exclusive of those used in the special Grass and Tobacco investigations, and those for "Traveling Expenses of the Staff" are exclusive of those used in the said investigations and also those used in the sampling of Foods and Fertilizers.

WM. H. BREWER,
Treasurer.

COMMERCIAL FERTILIZERS.

During 1898 fifty-four manufacturing firms have entered for sale in this State two hundred and eighty-nine distinct brands of fertilizers, viz.:

Special manures for particular crops, . . .	106
Other nitrogenous superphosphates, . . .	114
Bone manures and "bone and potash," . . .	38
Chemicals, including fish, tankage, and castor pomace, .	31
	<hr/>
	289

The duties of this Station regarding fertilizers are prescribed by law as follows:

THE FERTILIZER LAW OF CONNECTICUT.

The General Assembly, in 1882, passed an act concerning Commercial Fertilizers, which, as amended in 1893, is now in force.

Attention is especially called to the following requirements of the law, the full text of which is printed on pages 3 and 4.

1. In case of *all* fertilizers or manures, except stable manure and the products of local manufacturers of less value than ten dollars a ton, the law holds the SELLER responsible for *affixing a correct label or statement* to every package or lot sold or offered, as well as for the *payment of an analysis fee* of ten dollars for each fertilizing ingredient which the fertilizer contains or is claimed to contain, *unless* the MANUFACTURER OR IMPORTER has provided labels or statements and has paid the fee. Sections 4005 and 4007.

The Station understands "the fertilizing ingredients" to be those whose determination in an analysis is necessary for a valuation, and which are generally Nitrogen, Phosphoric Acid, and Potash. The analysis fees in case of any fertilizer will, therefore, usually be ten, twenty, or thirty dollars, according as one, two, or three of these ingredients are contained or claimed to exist in the fertilizer.

2. The law also requires, *in the case of every commercial fertilizer*, that a *sealed sample* shall be deposited with the Director

of the Station by the MANUFACTURER OR IMPORTER, and that a *certified statement* of composition, etc., shall be filed with him. Section 4006.

A statement of the per cent. of Nitrogen, Phosphoric Acid (P_2O_5), and Potash (K_2O), and of their several states or forms, will suffice in most cases. Other ingredients may be named if desired.

In all cases the per cent. of *nitrogen* must be stated. Ammonia may also be given when actually present in ammonia salts, and "ammonia equivalent to nitrogen" may likewise be stated.

The per cent. of soluble and reverted phosphoric acid may be given separately or together, and the term "available" may be used in addition to, but not instead of, soluble and reverted.

The percentage of insoluble phosphoric acid may be stated or omitted.

In case of Bone, Fish, Tankage, Dried Meat, Dried Blood, etc., the chemical composition may take account of the two ingredients, Nitrogen and Phosphoric Acid.

For Potash Salts give always the per cent. of Potash (potassium oxide): that of Sulphate of Potash or Muriate of Potash may also be stated.

The chemical composition of other fertilizers may be given as found in the Station Reports.

3. It is also provided that EVERY PERSON in the State, who sells *any commercial fertilizer of whatever kind or price*, shall annually report certain facts to the Director of the Experiment Station, and on demand of the latter shall deliver a sample for analysis. Section 4008.

4. All "CHEMICALS" that are applied to land, such as Muriate of Potash, Kainite, Sulphate of Potash and Magnesia, Sulphate of Ammonia, Nitrate of Potash, Nitrate of Soda, etc.—are considered to come under the law as "Commercial Fertilizers." Dealers in these chemicals must see that packages are suitably labeled. They must also report them to the Station, and see that the analysis fees are duly paid, in order that the Director may be able to discharge his duty as prescribed in Section 4013 of the Act.

It will be noticed that the State exacts no license tax either for making or dealing in fertilizers. For the safety of consumers and the benefit of honest manufacturers and dealers, the State requires that it be known what is offered for sale, and whether fertilizers are what they purport to be. With this object in view the law provides, in Section 4013, that all fertilizers be analyzed, and it requires the parties making or selling them to pay for these analyses in part; the State itself paying in part by maintaining the Experiment Station.

ACTS CONCERNING COMMERCIAL FERTILIZERS.

Chapter CCLIII of the General Statutes of Connecticut as amended by Chapter CLXXII of the Acts of the General Assembly, Session of 1893.

SECTION 4005. Every person or company who shall sell, offer, or expose for sale, in this State, any commercial fertilizer or manure except stable manure, and the products of local manufacturers of less value than ten dollars a ton, shall affix conspicuously to every package thereof a plainly printed statement clearly and truly certifying the number of net pounds of fertilizer in the package, the name, brand, or trademark under which the fertilizer is sold, the name and address of the manufacturer, the place of manufacture, and the chemical composition of the fertilizer, expressed in the terms and manner approved and usually employed by the Connecticut Agricultural Experiment Station.

If any such fertilizer be sold in bulk, such printed statement shall accompany every lot and parcel sold, offered, or exposed for sale.

SEC. 4006. Before any commercial fertilizer is sold, offered, or exposed for sale, the manufacturer, importer, or person who causes it to be sold, or offered for sale, within this State, shall file with the Director of the Connecticut Agricultural Experiment Station two certified copies of the statement prescribed in Section 4005, and shall deposit with said director a sealed glass jar or bottle containing not less than one pound of the fertilizer, accompanied by an affidavit that it is a fair average sample thereof.

SEC. 4007. The manufacturer, importer, agent, or seller of any commercial fertilizer shall pay on or before May 1, annually, to the Director of the Connecticut Agricultural Experiment Station, an analysis fee of ten dollars for each of the fertilizing ingredients contained or claimed to exist in said fertilizer: *provided*, that when the manufacturer or importer shall have paid the fee herein required for any person acting as agent or seller for such manufacturer or importer, such agent or seller shall not be required to pay the fee prescribed in this section.

SEC. 4008. Every person in this State who sells, or acts as local agent for the sale of any commercial fertilizer of whatever kind or price, shall annually, or at the time of becoming such seller or agent, report to the Director of the Connecticut Agri-

cultural Experiment Station his name and brand of said fertilizer, with the name and address of the manufacturer, importer, or party from whom such fertilizer was obtained, and shall, on demand of the Director of the Connecticut Agricultural Experiment Station, deliver to said director a sample suitable for analysis of any such fertilizer or manure then and there sold or offered for sale by said seller or agent.

SEC. 4009. No person or party shall sell, offer, or expose for sale, in this State, any pulverized leather, raw, steamed, roasted, or in any form, as a fertilizer or as an ingredient of any fertilizer or manure, without explicit printed certificate of the fact, such certificate to be conspicuously affixed to every package of such fertilizer or manure, and to accompany every parcel or lot of the same.

SEC. 4010. Every manufacturer of fish guano, or fertilizers of which the principal ingredient is fish or fish mass from which the oil has been extracted, shall, before manufacturing or heating the same, and within thirty-six hours from the time such fish or mass has been delivered to him, treat the same with sulphuric acid or other chemicals, approved by the director of said experiment station, in such quantity as to arrest decomposition: *provided, however*, that in lieu of such treatment such manufacturers may provide a means for consuming all smoke and vapors arising from such fertilizers during the process of manufacture.

SEC. 4011. Any person violating any provisions of the foregoing sections of this chapter shall be fined one hundred dollars for the first offense, and two hundred dollars for each subsequent violation.

SEC. 4012. This chapter shall not affect parties manufacturing, importing, or purchasing fertilizers for their own private use, and not to sell in this State.

SEC. 4013. The Director of the Connecticut Agricultural Experiment Station shall pay the analysis fees received by him into the treasury of the Station, and shall cause one or more analyses of each fertilizer to be made and published annually. Said director is hereby authorized, in person or by deputy, to take samples for analysis from any lot or package of manure or fertilizer which may be in the possession of any dealer.

SEC. 4014. The Director of the Connecticut Agricultural Experiment Station shall, from time to time, as bulletins of said Station may be issued, mail or cause to be mailed two copies, at least, of such bulletins to each post-office in the State.

OBSERVANCE OF THE FERTILIZER LAW.

Here follows an alphabetical list of the manufacturers who have paid analysis fees as required by the Fertilizer Law, and the names or brands of the fertilizers for which fees have been paid by them for the year ending May, 1899:

<i>Firm.</i>	<i>Brand of Fertilizer.</i>
Armour Fertilizer Works, Chicago, Ill.	Ammoniated Bone with Potash, Grain Grower, Bone, Blood, and Potash. All Soluble.
Baker, H. J. & Bro., 93 William St., N. Y. city.	Complete Tobacco Manure, "AA" Ammoniated Superphosphate, "Harvest Home" Fertilizer, Complete Potato Manure, Complete Manure for General Use, Standard UnXLD. Fertilizer, Vegetable, Vine, and Potato Manure, Castor Pomace.
Berkshire Mills Co., Bridgeport, Conn.	Berkshire Complete Fertilizer, Ammoniated Bone Phosphate, Ground Bone.
Boardman, F. E., Little River, Conn.	Boardman's Complete Manure for Po- tatoes and Vegetables.
Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	Stockbridge Special Tobacco Manure, " " Corn Manure, " " Grass Top Dress- ing and Forage Crop Manure, " " Potato and Vege- table Manure, Bowker's Special Fertilizer — Potato and Vegetables, " Potato Phosphate. " Hill and Drill Phosphate, " Farm and Garden, or Am- moniated Bone Fertilizer, " Fish and Potash, Square Brand, " Tobacco Starter, " Sure Crop Phosphate, " Market Garden Fertilizer, " Square Brand Bone and Potash, " Corn Phosphate, " Bone and Wood Ash Fertil- izer, " Tobacco Ash Elements, " " Fertilizer, " Middlesex Special, " Fisherman Brand Fish and Potash, " Dry Ground Fish,

<i>Firm.</i>	<i>Brand of Fertilizer.</i>
Bowker Fertilizer Co., 43 Chatham St., Boston, Mass.	Nitrate of Soda, Dissolved Bone Black, Muriate of Potash, Fresh Ground Bone, Tankage.
Bradley Fertilizer Co., 92 State St., Boston, Mass.	Bradley's Eclipse Phosphate, " High Grade Tobacco Manure, " Farmers' New Method Fertilizer, " Original Coe's Superphosphate, " B. D. Sea Fowl Guano, " Triangle A Fish and Potash, " Anchor Brand Fish and Potash, " Circle Brand Ground Bone with Potash, " Fine Ground Bone, " Complete Manure for Corn and Grain, " Complete Manure for Top-dressing Grass and Grain, " Complete Manure for Potatoes and Vegetables, " Potato Manure, " Superphosphate, " Corn Phosphate, " Potato Fertilizer, " Niagara Phosphate, " Tobacco Fertilizer.
Wm. E. Brightman, Tiverton, R. I.	Brightman's Fish and Potash, " Tobacco Special and Market Garden Fertilizer, " Ammoniated Bone and Potash, " Bone Meal, " Dry Ground Fish.
Buckingham, C., Southport, Conn.	XX Formula.
Burwell, E. E., New Haven, Conn.	Double Sulphate of Potash, Muriate of Potash, Blood and Meat, Dissolved Bone Black, Nitrate of Soda.
Clark's Cove Fertilizer Co., P. O. Box 1779, New York city.	Great Planet A. Manure, Bay State Fertilizer, G. G., Potato Fertilizer, King Philip Guano, Defiance Complete Manure, White Oak Pure Ground Bone.
Cleveland Dryer Co., 92 State St., Boston, Mass.	Cleveland Superphosphate, " High Grade Complete Manure, " Potato Phosphate,

<i>Firm.</i>	<i>Brand of Fertilizer.</i>
Cleveland Dryer Co., 92 State St., Boston, Mass.	Cleveland Fertilizer, " Pioneer Fertilizer, " Extra Fine Ground Bone.
Coe, E. Frank Co., 133-137 Front St., New York city.	E. Frank Coe's High Grade Ammoniated Bone Superphosphate, " High Grade Potato Fertilizer, " Gold Brand Excelsior Guano, " Ground Bone and Potash, " Special Tobacco Fertilizer.
Connecticut Reduction Co., Bridgeport, Conn.	Conn. Reduction Co.'s Fertilizer.
Connecticut Valley Orchard Co., Berlin, Conn.	C. V. O. Co's Phosphate.
Cooper's Glue Factory, Peter, 17 Burling slip, N. Y. city.	Bone Dust.
Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Crocker's Potato, Hop, and Tobacco Fertilizer, " Ammoniated Bone Superphosphate, " Wheat and Corn Phosphate, " New Rival Ammoniated Superphosphate, " Pure Ground Bone, " Special Potato Manure, " General Crop Phosphate, " Ground Bone Meal, " Vegetable Bone Superphosphate, " New England Tobacco and Potato Grower, " A. A. Complete Manure, " Universal Grain Grower,
Cumberland Bone-Phosphate Co., State St. and Merchants Row, Boston, Mass.	Cumberland Superphosphate, " Concentrated Phosphate, " Potato Fertilizer, " Fertilizer, " Hawkeye Fertilizer, " Extra Fine Ground Bone.
Darling Fertilizer Co., L. B., Pawtucket, R. I.	Potato and Root Brand, Animal Fertilizer, Tobacco Grower, Blood, Bone, and Potash, Dissolved Bone and Potash, G. Brand, Pure Fine Bone.
Dennis, E. C., Stafford Springs, Conn.	Ground Bone.

<i>Firm.</i>	<i>Brand of Fertilizer.</i>
Downs & Griffin, Derby, Conn.	Ground Bone.
F. Ellsworth, Hartford, Conn.	Shoemaker's Swift Sure Bone Meal, " " " Superphosphate.
Great Eastern Fertilizer Co., Rutland, Vermont.	Northern Corn Special, Vegetable, Vine, and Tobacco, Grass and Oats, General, Garden Special.
Hartford Fertilizer Co., Hartford, Conn.	Ground Bone.
Kelsey, E. R., Branford, Conn.	Bone, Fish, and Potash.
Lederer & Wolf, New Haven, Conn.	Pure Ground Bone.
Lister's Agricultural Chemical Works, Newark, N. J.	Success Fertilizer, Standard Pure Bone Superphosphate of Lime, Special Potato, Potato Manure, Bone and Potash.
Lowell Fertilizer Co., 44 No. Market St., Boston, Mass.	Lowell Bone Fertilizer, " Animal Fertilizer, " Potato Phosphate, " Tobacco Manure, " Ground Bone, Dissolved Bone and Potash, Market Garden, Fruit and Vine.
Luce Bros., Niantic, Conn.	Dry Ground Fish Guano, Bone, Fish, and Potash.
Ludlam, Frederick, 108 Water St., N. Y. city.	Cecrops, or Dragon's Tooth Brand, Cereal Brand.
Manchester, E. & Sons, West Winsted, Conn.	Manchester's Formula.
Mapes, F. & P. G. Co., The, 143 Lib- erty St., N. Y. city.	Potato Manure, Tobacco Manure (Wrapper Brand), Economical Potato Manure, Corn Manure, Complete Manure "A" Brand, Cereal Brand, Tobacco Starter, Fruit and Vine Manure, Vegetable Manure, or Complete Ma- nure for Light Soils, Grass and Grain Spring Top Dressing, Dissolved Bone, Tobacco Ash Constituents, Seeding Down Manure.
McCormack, William, Wolcott, Conn.	Ground Bone.

<i>Firm.</i>	<i>Brand of Fertilizer.</i>
Miller, George W., Middlefield, Conn.	Geo. W. Miller's Unexcelled Phosphate, " Pure Ground Bone.
Milsom Rendering & Fertilizer Co., 963 William St., East Buffalo, N. Y.	Potato, Hop, and Tobacco Phosphate, Buffalo Guano, Cyclone Bone, Wheat, Oats, and Barley Phosphate, Potato Special, Corn Fertilizer, Buffalo Fertilizer, Bone Meal, Dissolved Bone and Potash, Erie King, Dissolved Bone, Vegetable Bone Fertilizer.
National Fertilizer Co., Bridgeport, Conn.	Chittenden's Complete Fertilizers, " Ammoniated Bone, " Fish and Potash, " Market Garden, " Potato Phosphate, " Fine Ground Bone.
Niagara Fertilizer Works, The, Buf- falo, N. Y.	Niagara Triumph, " Wheat and Corn Producer, " Grain and Grass Grower, " Potato, Tobacco, and Hop Fertilizer.
Nuhn, Successor to Frederick, Water- bury, Conn.	Ground Bone.
Olds & Whipple, Hartford, Conn.	O. & W. Special Phosphate.
Pacific Guano Co., P. O. Box 1368, Boston, Mass.	Soluble Pacific Guano, Potato Special, Nobsque Guano, High Grade General Fertilizer, Grass and Grain Fertilizer, Fine Ground Bone.
Packers' Union Fertilizer Co., P. O. Box 1528, New York city.	Wheat, Oats, and Clover Fertilizer, Universal Fertilizer, Animal Corn Fertilizer, Potato Manure, Gardeners' Complete Manure.
Peck Bros., Northfield, Conn.	Pure Ground Bone.
Plumb & Winton Co., Bridgeport, Conn.	Ground Bone.
Preston Fertilizer Co., Greenpoint, L.I.	Potato and Onion, Potato, Potato and Corn Guano.
Quinnipiac Co., The, 92 State St., Bos- ton, Mass.	Phosphate, Potato Manure, Potato Phosphate,

<i>Firm.</i>	<i>Brand of Fertilizer.</i>
Quinnipiac Co., The, 92 State St., Boston, Mass.	Market Garden Manure, Grass Fertilizer, Corn Manure, Pure Bone Meal, Fish and Potash Crossed Fishes, Climax Phosphate, Pequot Fish and Potash, Onion Manure, Muriate Potash, Sulphate Potash, Sulphate Ammonia, Nitrate Soda, Dissolved Bone Black, Dry Ground Fish.
Read Fertilizer Co., Box 3121 New York city.	Read's Standard, Bone, Fish, and Potash, Vegetable and Vine, High Grade Farmer's Friend, Leader Guano, Practical Potato Special.
Rogers & Hubbard Co., Middletown, Conn.	Hubbard's Pure Raw Knuckle Bone Flour, " Strictly Pure Fine Bone, " Fertilizer for Oats and Top- dressing, " Fertilizer for All Soils and All Crops, " Potato Phosphate, " Soluble Potato Manure, " Fairchild's Formula, Corn and General Crops, " Soluble Tobacco Manure, " Grass and Grain Fertilizer.
Rogers Mfg. Co., Rockfall, Conn.	Pure Ground Bone, High Grade Soluble Potato, Complete Potato, Complete Corn, Oats and Top Dressing, High Grade Tobacco Manure, Grass and Grain Manure, Fish and Potash.
Russia Cement Co., Gloucester, Mass.	Essex XXX Fish and Potash, " Complete Manure for Potatoes, Roots, and Vegetables, " Complete Manure for Corn, Grain, and Grass, " Potato Fertilizer, " Tobacco Fertilizer.
L. Sanderson, New Haven, Conn.	Sanderson's Formula A, " Old Reliable Superphos- phate, " Potato Manure, " Special with 10% Potash Nitrate of Soda,

<i>Firm.</i>	<i>Brand of Fertilizer.</i>
L, Sanderson, New Haven, Conn.	Dissolved Bone Black, Blood, Bone, and Meat, Sulphate of Potash (Double), Muriate of Potash, Bone.
Standard Fertilizer Co., Farlow Building, State St., Boston, Mass.	Standard Fertilizer, " Special for Potatoes, " Guano, " Complete Manure.
Tucker, Henry F. Co., Farlow Building, State St., Boston, Mass.	Tucker's Special Potato Fertilizer, " Original Bay State Bone Superphosphate, " Bay State Special Fertilizer, " Imperial Bone Superphosphate.
Wheeler, M. E. & Co., Rutland, Vt.	M. E. Wheeler & Co.'s High Grade Corn Fertilizer, " " High Grade Potato Manure, " " Superior Truck Fertilizer, " " Havana Tobacco Grower, " " High Grade Fruit Fertilizer, " " High Grade Grass and Oats, " " High Grade Electrical Dissolved Bone, " " High Grade Pure Ground Bone.
Wilcox Fertilizer Works, Mystic, Conn.	Potato, Onion, and Tobacco Manure, Complete Bone Superphosphate, Potato Manure, High Grade Fish and Potash, Dry Ground Fish Guano.
Williams & Clark Fertilizer Co., 27 William St., N. Y. city.	Americus Ammoniated Bone Superphosphate, Americus Potato Phosphate, Corn Phosphate, Americus High Grade Special, Royal Bone Phosphate, Fine Wrapper Tobacco, Americus Pure Bone Meal, Potato Manure, Muriate of Potash, Kainit, Dissolved Bone Black, Dry Ground Fish.

SAMPLING AND COLLECTION OF FERTILIZERS.

During April, May, and June, Mr. V. L. Churchill, the sampling agent of this Station, visited one hundred and twenty-nine towns and villages of Connecticut, to draw samples of commercial fertilizers for analysis. These places were distributed as follows:—

Litchfield County,	12
Hartford County,	34
Tolland County,	12
Windham County,	12
New London County,	12
Middlesex County,	15
New Haven County,	18
Fairfield County,	14
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In these places 776 samples were taken, representing all but five of the brands which have been entered for sale in this State.

The brands entered for sale in this State, which the sampling agent was unable to find on sale and of which no samples were received from the manufacturers, were the following:—

H. J. Baker & Bro.'s Complete Manure, for general use.
 Cleveland Dryer Co.'s Extra Fine Bone.
 The E. Frank Coe Co.'s Special Tobacco Manure.
 Cumberland Fertilizer Co.'s Fertilizer.
 The Williams & Clark Fertilizer Co.'s Dissolved Bone Black.

It has not been possible, therefore, for the Station to make analyses of these five fertilizers.

When several samples of a single brand were drawn in different parts of the State, the analysis was performed, not on any single sample, but on a mixture made of an equal weight of each of the several samples. Thus, it is believed, the average composition of the goods is more fairly represented than by the analysis of any single sample.

The Station agent is instructed in every case to open at least three packages of each brand for sampling, and, if the number of packages is very large, to take a portion from every tenth one, by means of a sampling tube which withdraws a section or core through the entire length of the bag or barrel.

As a rule, the Station will not analyze samples taken—

1. From dealer's stock of less than one ton.
2. From stock which has lain over from last season.
3. From stock which evidently is improperly stored, as in bags lying on wet ground or exposed to the weather, etc.

The Station desires the coöperation of farmers, farmers' clubs and granges in calling attention to new brands of fertilizers, and in securing samples of all goods offered for sale. *All samples must be drawn in strict accordance with Station's Instructions for Sampling, and must also be properly certified, if the Station analysis is desired.* A copy of these instructions and blank certificates will be sent on application.

ANALYSES OF FERTILIZERS.

During the year, 569 samples of commercial fertilizers and manurial waste-products have been analyzed. A classified list of them is given on page 21.

On a few of these samples, analyses were made for private parties and charged for accordingly. A few others were analyzed at the request of other experiment stations in order to compare and test analytical methods. Results of the examination of all the samples, with these exceptions, are given in detail in the following pages. When the contrary is not stated, the samples were drawn by an agent of the Station.

Samples are analyzed as promptly as possible in the order in which they are received. As soon as an analysis is completed a copy of it is sent to the party who furnished the sample, and also to the manufacturer, in order that there may be opportunity for correction or protest, before the results are published.

The following "Explanations" are intended to embody the principles and data upon which the valuation of fertilizers is based, a knowledge of which is essential to a correct understanding of the analyses that are given on subsequent pages.

EXPLANATIONS CONCERNING THE ANALYSIS OF FERTILIZERS AND THE VALUATION OF THEIR ACTIVE INGREDIENTS.*

THE ELEMENTS OF FERTILIZERS.

The three chemical elements whose compounds chiefly give value, both commercial and agricultural, to fertilizers, are Nitrogen, Phosphorus, and Potassium. The other elements found in fertilizers, viz.: Sodium, Calcium, Magnesium, Iron, Silicon, Sulphur, Chlorine, Carbon, Hydrogen, and Oxygen, which are necessary or advantageous to the growth of vegetation, are either so abundant in the soil or may be so cheaply supplied to crops, that they do not considerably affect either the value or cost of high-priced commercial fertilizers.

NITROGEN in fertilizers is, on the whole, the least abundant of their valuable elements, and is, therefore, their most costly ingredient.

Free Nitrogen is universally abundant, making up nearly four-fifths of the common air, and appears to be directly assimilable by various low vegetable organisms, and with aid of certain bacteria, by leguminous plants (the clovers, alfalfa, peas, beans, lentils, esparsette, lupins, vetches, lathyrus, peanut, yellow locust, honey locust, etc.), and by a few non-leguminous plants, carrying root nodules, viz.: the Oleasters (*Eleagnus*), the Alders (*Alnus*), and a single family of coniferous trees (*Podocarpus*), but not at all, according to present evidence, by the cereals or other field and garden crops.

Organic Nitrogen is the nitrogen of animal and vegetable matters which is chemically united to carbon, hydrogen, and oxygen. Some forms of organic nitrogen, as those of blood, flesh, and seeds, are highly active as fertilizers; others, as found in leather and peat, are comparatively slow in their effect on vegetation, unless these matters are chemically disintegrated. Since organic nitrogen may often readily take the form of ammonia, it has been termed *potential ammonia*.

Ammonia (NH_3) and *Nitric Acid* (N_2O_5) are results of the chemical change of *organic nitrogen* in the soil and manure heap, and contain nitrogen in its most active forms. They occur in commerce—the former in sulphate of ammonia, the latter in nitrate of soda: 17 parts of ammonia, or 66 parts of pure sulphate of ammonia, contain 14 parts of nitrogen: 85 parts of pure nitrate of soda also contain 14 parts of nitrogen.

PHOSPHORUS is, next to nitrogen, the most costly ingredient of fertilizers, wherein it exists in the form of phosphates, usually those of calcium, iron, and aluminum, or in case of "superphosphates," to some extent in the form of free phosphoric acid.

Water-soluble Phosphoric Acid is phosphoric acid (or a phosphate) that freely dissolves in water. It is the characteristic ingredient of

* Prepared and revised by the Director.

superphosphates, in which it is produced by acting on "insoluble" (or "citrate soluble") phosphates, with diluted sulphuric acid. Once well incorporated with the soil, it gradually "reverts" and becomes insoluble, or very slightly soluble, in water.

Citrate-soluble Phosphoric Acid signifies the phosphoric acid (of various phosphates) that is freely taken up by a hot strong solution of neutral ammonium citrate, which solution is, therefore, used in analysis to determine its quantity. The designation *citrate-soluble* is synonymous with the less explicit terms *reverted*, *reduced*, and *precipitated*, which all imply phosphoric acid that was once easily soluble in water, but from chemical change has become insoluble in that liquid.

Recent investigation tends to show that water-soluble and citrate-soluble phosphoric acid are on the whole about equally valuable as plant food, and of nearly equal commercial value. In some cases, indeed, the water-soluble gives better results on crops; in others, the "reverted" is superior. In most instances there is probably little to choose between them.

Insoluble Phosphoric Acid implies various phosphates insoluble both in water and in hot solution of neutral ammonium citrate. The phosphoric acid of Canadian "Apatite," of South Carolina and Florida "Rock Phosphate," and of similar dense mineral phosphates, as well as that of "bone ash" and "bone black," is mostly insoluble in this sense, and in the majority of cases gives no visible good results when these substances, in the usual ground state, are applied to crops. They contain, however, a small proportion of citrate-soluble phosphoric acid, and sometimes, when they are reduced to extremely fine dust (floats) or applied in large quantities, especially on "sour soils" or in conjunction with abundance of decaying vegetable matter (humus), they operate as efficient fertilizers.

Available Phosphoric Acid is an expression properly employed in general to signify phosphoric acid in any form, or phosphates of any kind that serve to nourish vegetation. In the soil, phosphoric acid and all phosphates, whatever their solubilities as defined in the foregoing paragraphs, are more or less freely and extensively available to growing plants. Great abundance of "insoluble" phosphoric acid may serve crops equally well with great solubility of a small supply, especially when the soil and the crop carry with them conditions highly favorable to the assimilation of plant food.

In Commercial Fertilizers, "available phosphoric acid" is frequently understood to be the sum total of the "water-soluble" and the "citrate-soluble," with the exclusion of the "insoluble."

The "insoluble phosphoric acid" in a commercial fertilizer costing \$20 to \$50 per ton, has very little or no value to the purchaser, because the quantity of it which can commonly go upon an acre of land has no perceptible effect upon the crop, and because its presence in the fertilizer excludes an equal percentage of more needful and much more valuable ingredients.

In Raw Bone the phosphoric acid (calcium phosphate) is nearly

insoluble, because of the animal matter of the bones which envelopes it; but when the animal matter decays in the soil, or when it is disintegrated by boiling or steaming, the phosphate mostly remains in an available form. The phosphoric acid of "Basic-Slag" and of "Grand Cayman's Phosphate" is in some soils as freely taken up by crops as water-soluble phosphoric acid, but in other soils is much less available than the latter.

Phosphoric acid in all the Station analyses is reckoned as "anhydrous phosphoric acid" (P_2O_5), also termed among chemists phosphoric anhydride, phosphoric oxide, and phosphorus pentoxide.

POTASSIUM is the constituent of fertilizers which ranks third in costliness. In plants, soils, and fertilizers, it exists in the form of various salts, such as chloride (muriate), sulphate, carbonate, nitrate, silicate, etc. Potassium itself is scarcely known except as a chemical curiosity.

Potash signifies the substance known in chemistry as potassium oxide (K_2O), which is reckoned as the valuable fertilizing ingredient of "potashes" and "potash salts." In these it should be freely soluble in water and is most costly in the form of sulphate, and cheapest in the form of muriate (potassium chloride). In unleached ashes of wood and of cotton-seed hulls it exists mainly as potassium carbonate.

VALUATION OF FERTILIZERS.

The valuation of a fertilizer, as practised at this Station, consists in calculating the *retail Trade-value* or *cash-cost* (in raw material of good quality) of an amount of nitrogen, phosphoric acid, and potash equal to that contained in one ton of the fertilizer.

Plaster, lime, stable manure, and nearly all of the less expensive fertilizers have variable prices, which bear no close relation to their chemical composition, but guanos, superphosphates, and similar articles, for which \$30 to \$50 per ton are paid, depend for their trade-value exclusively on the substances, *nitrogen, phosphoric acid, and potash*, which are comparatively costly and steady in price. The trade-value per pound of these ingredients is reckoned from the current market prices of the standard articles which furnish them to commerce.

The consumer, in estimating the reasonable price to pay for high-grade fertilizers, should add to the *Trade-value of the above-named ingredients* a suitable margin for the expenses of manufacture, etc., and for the convenience or other advantage incidental to their use.

TRADE-VALUE OF FERTILIZER ELEMENTS FOR 1898.*

The average trade-values or retail costs in market, per pound, of the ordinarily occurring forms of nitrogen, phosphoric acid, and potash in raw materials and chemicals, as found in New England, New York, and New Jersey markets during 1897 were as follows:

* Adopted at a conference of representatives of the Connecticut, Massachusetts, New Jersey, and Rhode Island Stations held in March, 1898.

VALUATION OF FERTILIZERS.

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	Cents per pound.
Nitrogen in ammonia salts,	14
in nitrates,	14
Organic nitrogen, in dry and fine-ground fish, meat, and blood, and in mixed fertilizers,	14
in cotton-seed meal,	12
in fine* bone and tankage,	13½
in coarse* bone and tankage,	10
Phosphoric acid, water-soluble,	4½
citrate-soluble,†	4
of fine* ground fish, bone, and tankage,	4
of coarse* fish, bone, and tankage,	3½
of cotton-seed meal, castor pomace, and ashes,	4
of mixed fertilizers, if insoluble in ammonium citrate,†	2
Potash as high-grade sulphate and in forms free from muriate (or chlorides),	5
as muriate,	4¼

The foregoing are, as nearly as can be estimated, the prices at which, during the six months preceding March last, the respective ingredients were retailed for cash, in our large markets, in those *raw materials* which are the regular source of supply. They also correspond to the average wholesale price for the six months ending March 1st, plus about 20 per cent. in case of goods for which we have wholesale quotations. The valuations obtained by use of the above figures will be found to correspond fairly with the *average retail prices at the large markets, of standard raw materials, such as the following:*

* In this report "fine," as applied to bone and tankage, signifies smaller than $\frac{1}{8}$ inch; and "coarse," larger than $\frac{1}{8}$ inch. From 1878 on for 10 years, we distinguished five grades of bone, as to fineness. In 1888, one, in 1897 two of the coarser grades were dropped from the list. The smaller grades remain unchanged in dimensions, but "coarse" was for the first 10 years larger than $\frac{1}{4}$ inch, for the next 9 years included all larger than $\frac{1}{4}$ inch, for the next year all larger than $\frac{1}{4}$ inch, and in this year all larger than $\frac{1}{8}$ inch; the former "coarse-medium," "medium," and "fine-medium" having been successively merged in "coarse."

† Dissolved from 2 grams of the fertilizer, previously extracted with pure water, by 100 cc. neutral solution of ammonium citrate, sp. gr. 1.09, in 30 minutes, at 65° C., with agitation once in five minutes. Commonly called "reverted" or "backgone" Phosphoric Acid.

Sulphate of Ammonia,	Muriate of Potash,
Nitrate of Soda,	Sulphate of Potash,
Dried Blood,	Plain Superphosphates,
Azotin,	Dry Ground Fish,
Ammonite,	Bones and Tankage,
Ground South Carolina Rock.	

VALUATION OF SUPERPHOSPHATES, SPECIAL MANURES AND MIXED FERTILIZERS OF HIGH GRADE.

The Organic Nitrogen in these classes of goods is reckoned at the price of nitrogen in raw materials of the best quality,* 14 cents.

Insoluble Phosphoric Acid is reckoned at 2 cents per pound. Potash is rated at $4\frac{1}{4}$ cents, if sufficient chlorine is present in the fertilizer to combine with it to make muriate. If there is more Potash present than will combine with the chlorine, then this excess of Potash is reckoned at 5 cents per pound.

In most cases the valuation of the ingredients in superphosphates and specials falls below the retail price of these goods. The difference between the two figures represents the manufacturer's charges for converting raw materials into manufactured articles and selling them. The charges are for grinding and mixing, bagging or barreling, storage, and transportation, commission to agents and dealers, long credits, interest on investments, bad debts, and, finally, profits.

The majority of the manufacturers agree that the average cost of mixing, bagging, handling, and cartage ranges from \$3 to \$4.50 per ton.

In 1898 the average selling price of Ammoniated Superphosphates and Guanos was \$29.22 per ton, the average valuation was \$19.30, and the difference \$9.92, an advance of 51.4 per cent. on the valuation and on the wholesale cost of the fertilizing elements in the raw materials.

* This concession gives the dishonest manufacturer the opportunity to defraud the consumer very easily and very seriously, by "working off" inferior or almost worthless leather, bat guano, and similar materials which "analyze well," containing up to 8 or 9 per cent. of nitrogen, much or all of which may be quite inert. Since the Station has had no practicable means of determining with certainty the amount of worthless nitrogen or the quality of the nitrogen in a mixed fertilizer, and since the honest manufacturers (doubtless, the greater number) use only "materials of the best quality," it would be unjust to them to assume that these fertilizers contain anything inferior. Farmers should satisfy themselves that they are dealing only with honest and with intelligent manufacturers. This can be done at little cost by such co-operation as Farmers' Clubs and Granges may practice, sending a competent and trusty agent to visit factories frequently and unexpectedly, and take samples of raw materials. Honorable manufacturers will be glad to show all their raw materials and processes to their customers, especially if such inspection is insisted on as a preliminary to business. Co-operation may thus insure satisfactory quality of goods, as well as reduced cost.

In case of special manures the average cost was \$33.11, the average valuation \$21.72, and the difference \$11.39 or 52.4 per cent. advance on the valuation.

To obtain the *Valuation of a Fertilizer* we multiply the pounds per ton of nitrogen, etc., by the trade-value per pound. We thus get the values per ton of the several ingredients, and adding them together we obtain the total valuation per-ton.

In case of *Ground Bone and Tankage*, the sample is sifted into the two grades just specified (see footnote, page 17), and we separately compute the nitrogen-value of each grade by multiplying the pounds of nitrogen per ton by the per cent. of each grade, taking $\frac{1}{10}$ th of that product, multiplying it by the trade-value per pound of nitrogen in that grade, and taking this final product as the result in cents. Summing up the separate values of each grade thus obtained, together with the values of each grade of phosphoric acid, similarly computed, the total is the Valuation of the sample of bone.

USES AND LIMITATIONS OF FERTILIZER VALUATION.

The uses of the "Valuation" are two-fold:

1. To show whether a given lot or brand of fertilizer is worth, as a commodity of trade, what it costs. If the selling price is not higher than the valuation, the purchaser may be tolerably sure that the price is reasonable. If the selling price is twenty to twenty-five per cent. higher than the valuation, it may still be a fair price; but in proportion as the cost per ton exceeds the valuation there is reason to doubt the economy of its purchase.

2. Comparisons of the valuation and selling prices of a number of similar fertilizers will generally indicate fairly which is the best for the money.

But the valuation is not to be too literally construed, for in some cases analysis cannot discriminate positively between the active and the inert forms of nitrogen, while the mechanical condition of a fertilizer is an item whose influence cannot always be rightly expressed or appreciated.

For the above first-named purpose of valuation, the trade-values of the fertilizing elements which are employed in the computations should be as exact as possible, and should be frequently corrected to follow the changes of the market.

For the second-named use of valuation frequent changes of the trade-value are disadvantageous, because two fertilizers cannot be compared as to their relative money-worth when their valuations are deduced from different data.

Experience leads to the conclusion that the trade-values adopted at the beginning of the year should be adhered to as nearly as possible throughout the year, notice being taken of considerable changes in the market, in order that due allowance may be made therefor.

AGRICULTURAL VALUE OF FERTILIZERS.

The Agricultural Value of a fertilizer is measured by the benefits received from its use, and depends upon its fertilizing effect, or crop-producing power. As a broad, general rule, it is true that ground bone, superphosphates, fish scraps, dried blood, potash salts, etc., have a high agricultural value which is related to their trade-value, and to a degree determines the latter value. But the rule has many exceptions, and in particular instances the trade-value cannot always be expected to fix or even to indicate the agricultural value. Fertilizing effect depends largely upon soil, crop, and weather, and as these vary from place to place, and from year to year, it cannot be foretold or estimated except by the results of past experience, and then only in a general and probable manner.

CLASSIFICATION OF FERTILIZERS ANALYZED.

RAW MATERIALS.

1. *Containing Nitrogen as the Chief Valuable Ingredient.*

	NO. OF SAMPLES
Nitrate of Soda,	14
Sulphate of Ammonia,	2
Dried Blood,	2
Cotton-Seed Meal,	34
Castor Pomace,	5
Rape-Seed Meal,	1

2. *Containing Phosphoric Acid as the Chief Valuable Ingredient.*

Rock Phosphate,	3
Dissolved Bone Black,	8
Acid Phosphate,	10

3. *Containing Potash as the Chief Valuable Ingredient.*

High Grade Sulphate of Potash,	5
Double Sulphate of Potash and Magnesia,	9
Muriate of Potash,	19
Kainit,	4
Carbonate of Potash,	1
Silicate of Potash,	1
Phosphate of Potash,	1
Tobacco Stems,	4

4. *Containing Nitrogen and Phosphoric Acid.*

Bone Manures,	72
Tankage,	14
Fish,	6

MIXED FERTILIZERS.

Bone and Potash,	3
Nitrogenous Superphosphates and Guanos,	133
Special Manures,	114
Home Mixtures,	24

MISCELLANEOUS FERTILIZERS AND MANURES.

Cotton Hull Ashes,	48
Corn Cob Ashes,	1
Wood Ashes,	20
Lime Kiln Ashes,	2
Lime,	1
Marl,	1
Plaster,	1
Bat Guano,	1
Street Sweepings,	1
Ground Weed Seed,	1
Jadoo Fiber,	1
Rotted Peat,	2
Total,	569

DESCRIPTION AND ANALYSES OF FERTILIZERS.*

The samples referred to in the following pages, unless the contrary is stated, were drawn by an agent of the Station.

I. RAW MATERIALS CHIEFLY VALUABLE FOR NITROGEN.

NITRATE OF SODA OR SODIUM NITRATE.

Nitrate of Soda is mined in Chili and purified there before shipment. It contains about 16 per cent. of nitrogen, equivalent to 97 per cent. of pure sodium nitrate. The usual guarantee is "96 per cent." of sodium nitrate, equivalent to 15.8 per cent. of nitrogen.

In rare cases cargoes have been found to contain sodium perchlorate which, even in small amount, is very injurious to vegetation.

Fourteen analyses of nitrate of soda are given in a following table. The percentage of nitrogen ranges from 15.32, equivalent to 93 per cent. of nitrate,—to 16.04. All the samples are therefore of fair to good quality.

The prices ranged from \$40 to \$45 per ton.

The cost of nitrogen in nitrate of soda has ranged from 12.7 to 14.7 cents per pound, the average cost being 13.5 cents, a cent less than in the previous year.

* This chapter has been prepared for publication by Dr. Jenkins. The analyses of fertilizers have all been made by Messrs. Winton, Ogden, and Mitchell, chemists of the Station, with the assistance of Mr. Lange.

ANALYSES OF NITRATE OF SODA.

Station No.	Sold by	Sampled from Stock of	Nitrogen.	Equivalent Nitrate.	Cost per ton.	Nitrogen costs cents per pound.
10377	M. L. Shoemaker & Co., Philadelphia.....	Daniels Bros., Middletown,.....	15.72	95.42	\$40.00	12.7
10304	Bowker Fertilizer Co., Boston,.....	W. H. Todd, North Haven,.....	16.04	97.36	41.00	12.7
10310	Bowker Fertilizer Co., Boston,.....	Fred. R. Jennings, Greenfield Hill,.....	15.58	94.57	40.00	12.8
10550	Bradley Fertilizer Co., Boston,.....	G. B. Porter, Waterbury,.....	15.40	93.48	40.00	13.0
10513	L. Sanderson, New Haven,.....	E. Manchester & Sons, West Winsted,.....	15.32	92.99	40.00	13.1
10556	E. E. Burwell, ".....	E. E. Burwell, New Haven,.....	15.94	96.76	42.00	13.2
10500	F. S. Bidwell, Windsor Locks,.....	George Rengerman, East Granby,.....	15.46	93.84	41.00	13.3
10444	Bowker Fertilizer Co., Boston,.....	Clifton Peck, Yantic,.....	15.60	94.69	43.00	13.8
10372	L. Sanderson, New Haven,.....	Dennis Fenn, Milford,.....	15.88	96.39	45.00	14.1
10361	Quinnipiac Company, Boston,.....	Olds & Whipple, Hartford,.....	15.80	95.91	45.00	14.2
10263	L. Sanderson, New Haven,.....	L. Sanderson, New Haven,.....	15.70	95.30	45.00	14.3
10428	L. Sanderson, ".....	Chas. B. Sheldon, W. Suffield,.....	15.14	91.90	45.00	14.7
10249	.....	S. D. Woodruff & Sons, Orange,.....	15.76	95.66	.....	.....
10102	L. Sanderson, New Haven,.....	Agricultural Station,.....	15.89	.....	.....	.....

SULPHATE OF AMMONIA, OR AMMONIUM SULPHATE.

This article, now made on a large scale as a by-product of gas works and coke ovens, usually contains over 20 per cent. of nitrogen, the equivalent of 94-97 per cent. of ammonium sulphate. The rest is chiefly moisture. The usual guarantee is 25 per cent. of ammonia, which is equivalent to 20.6 per cent. of nitrogen.

10380. Sold by Quinnipiac Co., Boston, Mass. Sampled from stock of Olds & Whipple, Hartford.

10658. Sold by L. Sanderson, New Haven. Sampled from stock of J. C. Eddy, Simsbury.

ANALYSES.

	10380	10658
Nitrogen,	20.94	20.94
Equivalent Ammonia,	25.43	25.43
Cost per ton,	\$60.00	\$65.00
Nitrogen costs cents per pound,	14.3	15.5

At these prices sulphate of ammonia is an expensive source of nitrogen as compared with nitrate of soda and the organic forms, and is not likely to be used much as a fertilizer.

DRIED BLOOD.

This consists of slaughter-house blood which has been dried by superheated steam or hot air. It is a finely pulverized, nearly odorless substance, red or nearly black in color, and rich in nitrogen that is quickly available to vegetation.

10314. Sold by the Bowker Fertilizer Co., Boston, Mass. Sampled from stock of Simeon Pease, by Fred. R. Jennings, Greenfield Hill.

10589. Sold by L. Sanderson, New Haven. Sampled by Geo. H. Bartlett, North Guilford, from stock bought by him.

ANALYSES.

	10314	10589
Nitrogen,	10.70	10.13
Phosphoric Acid, . . . . .	.....	4.16
Cost per ton,	\$28.00	\$26.00
Nitrogen costs cents per pound,	13.1	11.4*

Of the nitrogen of **10314**, 87.3 per cent. were soluble in pepsin solution, demonstrating the absence of any such adulterant as ground leather.

* Allowing 3½ cents per pound for the phosphoric acid.

COTTON-SEED MEAL.

This material is of two kinds, which are known in trade respectively as undecorticated and decorticated. In their manufacture cotton seed is first ginned to remove most of the fiber, then passed through a "linter" to take off the short fiber or lint remaining, then through machines which break and separate the hulls. The hulled seed is ground and the oil expressed. The ground cake from the presses is used as a cattle food and fertilizer. The hulls are burned for fuel in the oil factory, and the ashes, which contain from 20 to 30 per cent. of potash, are also used as a fertilizer. In case of undecorticated meal, the hulls and the ground press-cake are mixed together.

The only samples received for analysis this year have represented clear, decorticated meal.

In the following table are given the percentages of nitrogen in thirty-four samples. The percentage of phosphoric acid in cotton-seed meal ranges from 2.69 to 3.44, and that of potash from 1.64 to 2.00, the average being 3.15 and 1.90, respectively. The cost per pound of nitrogen is determined in each case by deducting from the ton price \$4.42—the valuation of the phosphoric acid and potash,—and dividing the remainder by the number of pounds of nitrogen in the ton of meal.

The average cost of cotton-seed meal has been about \$21.50 per ton. The percentage of nitrogen has ranged from 7.04 to 7.97 and has averaged 7.44. The cost of nitrogen per pound has ranged from 10.2 to 12.4 cents, averaging 11.5 cents per pound, the cheapest form of quickly available organic nitrogen in our market.

CASTOR POMACE.

This is the ground residue of castor beans from which castor oil has been extracted. The nitrogen which it contains is quickly available to plants, but the pomace is extremely poisonous to animals, which often eat it greedily when the opportunity offers.

10384. Made by H. J. Baker & Bro., N. Y. city. Stock of Olds & Whipple, Hartford.

10846. Made by H. J. Baker & Bro., N. Y. city. Stock of J. C. Eddy, Simsbury.

10190. Made by H. J. Baker & Bro., N. Y. city. Stock of Olds & Whipple, Hartford.

ANALYSES OF COTTON SEED MEAL.

Station No.	Dealer.	Sampled by	Nitrogen.	Cost per ton.	Nitrogen costs cents per pound.
10191	McBride & Co., Memphis, Tenn.,	S. A. Kent, Suffield, Conn.,	7.81	\$20.40	10.2
10216	American Cotton Oil Co., New York City,	Edward O. Marsh, New Milford,	7.97	20.50	10.4
10194	W. W. Cooper, Suffield,	C. D. Woodworth, Thompsonville,	7.96	21.00	10.7
10495	Morton Bancroft, Springfield, Mass.	Henry Derwig, Warehouse Point,	7.56	21.00	11.0
10272	Chapin & Co., Boston,	E. Manchester & Sons, West Winsted,	7.37	20.75	11.0
10357	J. E. Perkins, Suffield,	F. B. Hatheway, Windsor Locks,	7.57	21.25	11.1
10498	W. W. Cooper, Suffield,	Station Agent,	7.60	21.50	11.2
10499	H. K. Brainerd, Thompsonville,	Station Agent,	7.61	21.50	11.2
10429	W. W. Cooper, Suffield,	Chas. B. Sheldon, West Suffield,	7.40	21.00	11.2
10298	C. H. Dexter & Son, Windsor Locks,	E. S. Seymour, Windsor Locks,	7.50	21.50	11.4
10370	Bowlers Branch, Hartford,	H. W. Alford, Poquonock	7.38	21.25	11.4
10323	Olds & Whipple,	Pitcher & Phillips, Thompsonville,	7.58	21.75	11.4
10279	W. W. Cooper, Suffield,	S. O. Ranney, Windsor Locks,	7.22	21.00	11.5
10361	Arthur Sikes, Mapleton,	D. I. King, Windsor Locks,	7.18	21.00	11.5
10500	H. K. Brainerd, Thompsonville,	Station Agent,	7.42	21.50	11.5
10215	Ernest N. Austin, Suffield,	H. H. Austin, Suffield,	7.42	21.50	11.5
10308	American Cotton Oil Company,	W. H. Olcott, So. Manchester,	7.55	22.00	11.6
10371	.....	P. P. Hickey, Burnside,	7.43	21.75	11.7
10479	Olds & Whipple, Hartford,	Stanton F. Brown, Poquonock,	7.73	22.50	11.7
10234	Arthur Sikes, Suffield,	G. A. Douglass, Thompsonville,	7.34	21.50	11.7
10724	C. M. Cox & Co., Boston, Mass.,	C. J. Dewey, Buckland,	7.30	21.50	11.7
10570	American Cotton Oil Company,	N. T. Case, Tariffville,	7.42	22.00	11.9
10409	C. H. Dexter & Son, Windsor Locks,	Fred. Thrall, Poquonock,	7.10	21.50	12.0
10408	Olds & Whipple, Hartford,	John Du Bon,	7.10	21.50	12.0
10322	Olds & Whipple, Hartford,	T. P. Kinney, Windsor,	7.29	22.00	12.0
10432	C. F. Tallard & Son, Broad Brook,	C. D. Cannon, Windsor Locks,	7.04	21.50	12.1
10297	Olds & Whipple, Hartford,	Clark Bros., Poquonock,	7.49	22.50	12.1
10278	.....	W. H. Prout, Suffield,	7.54	22.75	12.2
10288	Olds & Whipple, Hartford,	A. E. Holcomb, Poquonock,	7.23	22.50	12.2
10436	Olds & Whipple, Hartford,	A. H. Brown,	7.30	22.50	12.4
10120	.....	A. E. Plant, Branford,	7.66	.....	.....
10179	C. A. Pease & Co., Hartford,	C. A. Pease & Co., Hartford,	7.48	.....	.....
10549	Charles M. Cox & Co., Boston, Mass.,	Chas. M. Cox & Co., Boston, Mass.,	7.34	.....	.....
10163	L. Sanderson, New Haven,	Agricultural Station,	7.40	.....	.....

10189. Made by H. J. Baker & Bro., N. Y. city. Sampled from stock of Olds & Whipple, Hartford, by E. P. Brewer, Silver Lane.

10845. Sold by the Bowker Fertilizer Co., Boston, Mass. Stock of Newell St. John, Simsbury.

ANALYSES.

	10384	10846	10190	10189	10845
Nitrogen,	5.70	5.50	5.34	5.02	4.60
Phosphoric Acid,	1.60	....	1.64	1.43	....
Potash,	0.95	....	0.77	0.91	....
Cost per ton,	\$19.00	\$19.00	\$19.00	\$19.00	\$19.00
Nitrogen costs					
cents per pound,	14.7	15.3	15.9	16.8	18.3

The percentage of nitrogen in these samples of castor pomace has a rather wide range, 4.60 to 5.70, and the cost of nitrogen per pound is much higher than in cotton seed meal. Many tobacco-growers, however, use castor pomace, believing that it imparts a desirable quality to the wrapper leaf, which is not obtained by cotton-seed meal. The experiments made by this Station for five successive years failed to show any advantage from the use of castor pomace in place of cotton seed meal as a tobacco fertilizer.

RAPE-SEED MEAL.

10220. A sample of this material, made by the Oil Seeds Pressing Co., 15-25 Whitehall street, New York city, and used by J. A. DuBon, Poquonock, in an experiment to test its value as a tobacco fertilizer, contained:

Nitrogen,	5.40 per cent.
Phosphoric Acid,	2.16 "
Potash, . . . . .	.99 "

In composition it is not unlike castor pomace. As a tobacco fertilizer it did not prove satisfactory in 1898.

II. RAW MATERIALS OF HIGH GRADE CONTAINING PHOSPHORIC ACID AS THE CHIEF VALUABLE INGREDIENT.

DISSOLVED BONE BLACK.

Bone black, made by subjecting bone to a red heat without access of air, is used in sugar refineries to decolorize sugar solutions. The waste bone black, dried and treated with oil of vitriol, makes a "superphosphate" of high grade which does not cake together on standing, but remains as a fine powder suitable for application to the land.

In the following table are given analyses of seven samples of this material.

The cost of available phosphoric acid in dissolved bone black has ranged from 6.0 to 6.9 cents per pound, the average in the seven samples being 6.5 cents.

ANALYSES OF DISSOLVED BONE BLACK AND (☞)

Station No.	Sold by	Sampled from Stock of
<i>Dissolved Bone Black.</i>		
10721	Quinnipiac Co., Boston,	O. S. Olmsted, Melrose,
10588	Bowker Fertilizer Co., Boston,	A. L. Hitchcock, Plainville,
10260	E. E. Burwell, New Haven,	E. E. Burwell, New Haven,
10274	L. Sanderson, "	E. Manchester & Sons, W. Winsted,
10262	" " "	L. Sanderson, New Haven,
10427	" " "	Chas. B. Sheldon, West Suffield,
10373	" " "	Dennis Fenn, Milford,
<i>Dissolved Rock Phosphate.</i>		
10643	Geo. F. Taylor's Sons, N. Y. city,	H. C. C. Miles, Milford,
10386	M. L. Shoemaker & Co., Phila.,	Daniels Bros., Middletown,
10385	Bowker Fertilizer Co., Boston,	W. B. Miller, Middlefield,
10458	" " " "	Clifton Peck, Yantic,
10554	Bradley " " "	G. B. Porter, Waterbury,
10741	M. E. Wheeler & Co., Rutland, Vt.,	D. G. Chesebro, Center Groton,
10202	Berkshire Mills Co., Bridgeport,	S. E. Curtis, Stratford,
10250		S. D. Woodruff & Sons, Orange,
10714	Milsom Rendering & Fertilizer Co.,	
	East Buffalo, N. Y.,	Manufacturer,
10276	Quinnipiac Co., Boston,	C. Buckingham, Southport,

DISSOLVED ROCK PHOSPHATE OR ACID ROCK.

This material, made by treating various mineral phosphates with oil of vitriol, is the most common source of the phosphoric acid of factory-mixed fertilizers.

In the following table are given ten analyses of dissolved rock phosphate. The composition of the samples is by no means uniform.

The cost of available phosphoric acid ranges from 3.1 to 7.4 cents per pound, the average of six samples being 3.9 cents.

10741 is "Electrical Dissolved Bone," sold by M. E. Wheeler & Co. It is simply dissolved mineral phosphate, sold for about double the price of the other samples.

DISSOLVED ROCK PHOSPHATE.

PHOSPHORIC ACID.				Cost per ton.	"Available" Phosphoric Acid costs cents per pound.
Soluble.	Reverted.	Insoluble.	Total.		
12.90	3.41	.74	17.05	\$20.00	6.0
13.92	2.12	.18	16.22	19.50	6.1
11.97	5.04	.45	17.46	22.00	6.4
16.00	.37	.15	16.52	22.00	6.7
15.54	.60	.11	16.25	22.00	6.8
15.39	.86	.16	16.41	22.00	6.8
15.79	....	.51	16.30	22.00	6.9
12.93	2.02	.26	15.21	10.25	3.4
10.59	2.98	1.83	15.40	11.00	3.8
9.34	3.32	1.78	14.44	11.00	4.1
9.63	4.10	1.48	15.21	12.00	4.2
8.67	3.37	2.05	14.09	12.00	4.6
8.98	4.90	1.16	15.04	21.00	7.4
9.22	7.87	.47	17.56	11.00	3.1
12.46	1.42	.83	14.71	....	...
10.19	3.09	.17	13.45	....	...
10.42	3.70	1.62	15.74	....	...

III. RAW MATERIALS OF HIGH GRADE CONTAINING POTASH.

HIGH GRADE SULPHATE OF POTASH.

This chemical should contain over 90 per cent. of pure potassium sulphate (sulphate of potash) or about fifty per cent. of potassium oxide, the same quantity as is supplied by muriate, and should be nearly free from chlorine.

In the table, on pages 32 and 33, are given five analyses of high grade sulphate, all of them of fair quality.

DOUBLE SULPHATE OF POTASH AND MAGNESIA.

This material is usually sold as "sulphate of potash" or "manure salt," on a guarantee of "48-50 per cent. sulphate," which is equivalent to 25.9-27.0 per cent. of potassium oxide. Besides some 46-50 per cent. of potassium sulphate, it contains over 30 per cent. of magnesium sulphate, chlorine equivalent to 3 per cent. of common salt, a little sodium and calcium sulphates, with varying quantities of moisture.

The analyses of eight samples of this material appear in the table on pages 32 and 33. Two of them, Nos. 10294 and 10343, contain considerably less potash than this material is usually guaranteed to contain, and in two others, 10235 and 10733, the percentage of potash is rather low.

MURIATE OF POTASH.

Commercial muriate of potash contains about 80 per cent. of muriate of potash (potassium chloride), 15 per cent. or more of common salt (sodium chloride), and 4 per cent. or more of water.

It is generally retailed on a guarantee of 80 per cent. muriate, which is equivalent to 50.5 per cent. of potassium oxide.

The percentages of potash in the seventeen samples whose analyses appear in the table, pages 32 and 33, range from 53.67 to 48.77, and average 51.1 per cent.

KAINIT.

Kainit is less uniform in composition than the other potash salts. It contains from 11 to 15 per cent. of potash, more than that quantity of soda, and rather less magnesia. These "bases" are combined with chlorine and sulphuric acid. Un-

less "calcined" it contains more water than occurs in sulphate or in muriate of potash. It is usually sold on a guarantee of 12 to 15 per cent. of potash, or 23 to 25 per cent. "sulphate of potash." It is not properly called or claimed to be a sulphate of potash, since it contains more than enough chlorine to combine with all the potash present, and there are sound reasons for believing that its potash exists largely as muriate and to a much less extent as sulphate. Its action and effects are unquestionably those of a muriate rather than of a sulphate.

Four analyses of kainit appear in the table, pages 32 and 33. The percentage of potash ranges from 11.14 to 13.80.

In 1898, the cost of potash in the samples of high grade sulphate of potash analyzed at this station, five in number, ranged from 4.6 cents to 5.1 cents per pound, and averaged 4.8.

The cost of potash in the "low grade" or double sulphate of potash and magnesia ranged from 4.9 to 6.8 cents per pound and averaged (8 samples) 5.8 cents, a cent more per pound than in the high grade sulphate.

In eleven samples of muriate of potash, the cost per pound of potash ranged from 3.8 to 4.5 cents per pound, and averaged 4.2 cents, this being the cheapest source of water-soluble potash in the market.

The cost of potash in Kainit ranged from 5.1 cents to 6.3 cents per pound.

ANALYSES OF (☞)

Station No.	Sold by	Sampled from Stock of.
<i>High Grade Sulphate of Potash.</i>		
10426	L. Sanderson, New Haven,.....	Chas. B. Sheldon, W. Suffield,....
10512	L. Sanderson, New Haven,.....	E. Manchester & Sons, W. Winsted,
10553	Bradley Fertilizer Co., Boston,.....	G. B. Porter, Waterbury,.....
10313	Bowker Fertilizer Co., Boston,.....	F. R. Jennings, Greenfield Hill,..
10345	Bowker Fertilizer Co., Boston,.....	Bowker's Branch, Hartford,.....
<i>Double Sulphate of Potash and Magnesia.</i>		
10293	Bradley Fertilizer Co., Boston,.....	James P. O'Connor, Wethersfield,
10259	E. E. Burwell, New Haven,.....	E. E. Burwell, New Haven,.....
10261	L. Sanderson, New Haven,.....	L. Sanderson, New Haven,.....
10235	Ernest N. Austin, Suffield,.....	H. H. Austin, Suffield,.....
10379	Quinnipiac Co., Boston,.....	Olds & Whipple, Hartford,.....
10294	Bowker Fertilizer Co., Boston,.....	James P. O'Connor, Wethersfield,
10343	Bowker Fertilizer Co., Boston,.....	Bowker's Branch, Hartford,.....
10733	Bowker Fertilizer Co., Boston,.....	H. K. Brainard, Thompsonville,..
<i>Muriate of Potash.</i>		
10555	Bradley Fertilizer Co., Boston,.....	G. B. Porter, Waterbury,.....
10257	E. E. Burwell, New Haven,.....	E. E. Burwell, New Haven,.....
10312	Bowker Fertilizer Co., Boston,.....	F. R. Jennings, Greenfield Hill,..
10659	Williams & Clark Fertilizer Co., New York,.....	J. G. Schwink, Meriden,.....
10442	L. Sanderson, New Haven,.....	E. C. Warner, Fair Haven,.....
10305	Rogers & Hubbard Co., Middletown,.....	H. W. Andrews, Wallingford,....
10371	L. Sanderson, New Haven,.....	D. Fenn & Son, Milford,.....
10266	L. Sanderson, New Haven,.....	L. Sanderson, New Haven,.....
10344	Bowker Fertilizer Co., Boston,.....	Bowker's Branch, Hartford,.....
10378	Quinnipiac Co., Boston,.....	Olds & Whipple, Hartford,.....
10552	Great Eastern Fertilizer Co., Rutland, Vt.,.....	Wm. M. Tyler, Waterbury,.....
10203	Berkshire Mills Co., Bridgeport,.....	S. E. Curtis, Stratford,.....
10443	Bowker Fertilizer Co., Boston,.....	Clifton Peck, Yantic,.....
10242	.....	S. D. Woodruff & Sons, Orange,...
10248	.....	.....
10273	.....	E. Manchester & Sons, W. Winsted,
10603	Geo. F. Taylor's Sons, N. York City,	H. C. C. Miles, Milford,.....
<i>Kainit.</i>		
10433	.....	D. Fenn, Milford,.....
10734	Bowker Fertilizer Co., Boston,.....	H. K. Brainard, Thompsonville,..
10657	Williams & Clark Fertilizer Co., New York,.....	J. G. Schwink, Meriden,.....
10346	Bowker Fertilizer Co., Boston,.....	Bowker's Branch, Hartford,.....

POTASH SALTS.

Per cent. Potash.	Equivalent Sulphate of Potash.	Equivalent Muriate of Potash.	Cost per ton.	Potash costs cents per pound.
49.39	91.37	.....	\$45.00	4.6
48.48	89.69	.....	45.00	4.6
49.83	92.19	.....	47.00	4.7
48.35	89.45	.....	47.00	4.9
47.90	88.62	.....	49.00	5.1
26.62	49.25	.....	26.00	4.9
26.14	48.36	.....	28.00	5.4
25.78	47.69	.....	28.00	5.4
23.96	44.33	.....	28.00	5.8
27.12	50.17	.....	32.00	5.9
22.22	41.11	.....	26.00	5.9
23.03	42.61	.....	30.00	6.5
24.16	44.70	.....	33.00	6.8
52.14	.....	82.38	40.00	3.8
53.00	.....	83.74	41.50	3.9
49.68	.....	78.49	40.00	4.0
50.40	.....	79.63	42.00	4.1
50.22	.....	79.35	42.00	4.2
50.96	.....	80.52	42.50	4.2
50.14	.....	79.22	42.00	4.2
49.39	.....	78.04	42.50	4.3
50.15	.....	79.24	43.00	4.3
50.97	.....	80.53	45.00	4.4
50.50	.....	79.79	45.00	4.5
53.59	.....	84.67	.....	.....
50.98	.....	80.55	.....	.....
48.77	.....	77.06	.....	.....
53.12	.....	83.93	.....	.....
53.67	.....	84.80	.....	.....
51.91	.....	82.02	40.40	3.9
13.80	25.53	.....	14.00	5.1
12.14	22.46	.....	14.00	5.8
11.74	21.72	.....	14.00	5.9
11.14	20.61	.....	14.00	6.3

HIGH GRADE SCOTCH MURIATE OF POTASH.

This material has a coarser grain than the German muriate. A sample, 10755, sent by Chas. H. Weekes, 54 Maiden Lane, New York, contained 61.58 per cent. of potash soluble in water, which is about the quantity guaranteed by the manufacturers. Mr. Weekes states that it is sold at a somewhat lower price than the German muriate.

CARBONATE OF POTASH.

10296. A white, dry powder containing many small lumps, sold by the cask at \$110.00 per ton. Sampled by Clark Bros., Poquonock. It is used by the Clark Bros. as a potash fertilizer for tobacco, being applied to the land, in solution, from a watering cart. The results are stated by the Clark Brothers to have been most satisfactory, both as regards yield of crop and quality of leaf.

The sample contained 64.55 per cent. of water-soluble potash, equivalent to 94.70 per cent. of carbonate of potash. Actual potash in this material cost 8.5 cents per pound, more than in any commonly used tobacco fertilizer.

SILICATE OF POTASH.

10481. A sample of silicate of potash, mixed with a little peat, which was given to the Station by the German Potash Syndicate for experimental use as a tobacco fertilizer, contained 19.40 per cent. of water-soluble potash and 21.50 per cent. of total potash.

PHOSPHATE OF POTASH.

A sample, 10482, analyzed for the Storrs Station, contained 51.60 per cent. of potash and 41.23 per cent. of phosphoric acid, both soluble in water.

TOBACCO STEMS.

These consist, not of the stalks, but of the midribs of the leaves, stripped off in cigar factories. They are much used on tobacco lands, and, being free from weed seeds, make an excellent fertilizer and mulch for lawns, applied late in the fall.

10383. Broken tobacco stems. Bought of the P. J. Sorg Co., Middletown, Ohio. 10463. Ground stems, and 10496, unground stems; the three samples taken from stock of Olds & Whipple, Hartford.

ANALYSES.

	10383	10463	10496
Nitrogen, . . .	1.55	1.05	1.07
Phosphoric Acid, . .	.47	.49	1.15
Potash, . . .	4.96	5.60	5.32
Cost per ton, . . .	\$15.00	\$18.00	\$11.50

If we allow 14 and 4 cents per pound for nitrogen and phosphoric acid respectively, the cost of potash per pound, in the three samples, will be 10.4, 13.1, and 7.1 cents. It is evident that if the value of stems as a fertilizer rests wholly in their content of nitrogen, phosphoric acid, and potash they are uneconomical to buy at present prices.

But, like stable manure, they are also valuable for the organic, humus-forming material in them.

IV. RAW MATERIALS CONTAINING NITROGEN AND PHOSPHORIC ACID.

BONE MANURES.

The terms "Bone Dust," "Ground Bone," "Bone Meal," and "Bone" applied to fertilizers, sometimes signify material made from dry, clean, and pure bones; in other cases these terms refer to the result of crushing fresh or moist bones which have been thrown out either raw or after cooking, with more or less meat, tendon, and grease, and—if taken from garbage or ash heaps—with ashes or soil adhering; again they denote mixtures of bone, blood, meat, and other slaughter-house refuse which have been cooked in steam tanks to recover grease, and are then dried and sometimes sold as "tankage"; or finally, they apply to bone from which a large share of the nitrogenous substance has been extracted in the glue manufacture. When they are in the same state of mechanical subdivision the nitrogen of all these varieties of bone probably has about the same fertilizing value.

The method adopted for the valuation of bone manures, which takes account of their mechanical condition as well as chemical composition, is explained on page 19.

1. *Bone Manures Sampled by Station Agents.*

In the following table are given analyses of forty-four samples of bone drawn by the Station agents. See pages 38 and 39.

The average cost per ton has been \$29.49; the average valuation \$25.55, showing that the Station schedule of valuations for bone has been lower than is justified by the average selling price of bone.

Analyses Requiring Special Notice.

The Bradley Fertilizer Co. was dissatisfied with the results of analysis No. **10394**, pp. 38 and 39, and asked that other samples be drawn and analyzed. Another sample, **10537**, pp. 38 and 39 was accordingly analyzed, which gave higher percentages of both nitrogen and phosphoric acid. Both analyses appear in the table.

The Lowell Fertilizer Co. was dissatisfied with analysis No. **10596**, pp. 38 and 39, stating that this brand usually contained from 2.27 to 2.69 per cent. of nitrogen, while our analysis showed only 2.03 per cent.

Nitrogen was then determined in each of the three samples, with the following results: 2.10, 1.96, 1.86; average, 1.97 per cent.; found in the mixture of the three, 2.03 per cent.

Two samples were then drawn from the stock of the Standard Feed Co., in Bridgeport, **10753** and **10754**; analyses, pp. 38 and 39.

The former was from bags, labeled and tagged, and contained 2.02 per cent. of nitrogen; the latter, from unlabeled bags, said by the manufacturer to be poultry bone, contained 2.25 per cent.

The Lowell Fertilizer Co. next asked that further samples be drawn from a number of places, by representatives of the Station and the Company, which was accordingly done.

The six samples, thus drawn, **10825** to **10830**, both inclusive, are given in the table, and all the analyses of this brand are tabulated below for ready comparison.

Analyses of the Lowell Fertilizer Company's Ground Bone.

MECHANICAL ANALYSES.

	10569	10753	10754	10825	10826	10827	10828	10829	10830
Smaller than $\frac{1}{16}$ inch,	60	68	63	66	65	67	68	60	63
Larger than $\frac{1}{16}$ inch,	40	32	37	34	35	33	32	40	37
Total,	100	100	100	100	100	100	100	100	100

CHEMICAL ANALYSES AND VALUATIONS.

Nitrogen,	2.03	2.02	2.25	1.87	1.90	2.17	1.61	2.23	2.10
Phosphoric acid,	29.31	29.44	28.68	29.07	29.18	28.45	29.58	28.29	29.16
Cost per ton,	\$30.00	28.00	28.00	30.00	30.00	30.00	30.00	30.00	30.00
Valuation per ton,	\$27.26	27.61	27.40	26.87	27.02	27.21	26.71	26.90	27.41

An inspection of all these analyses shows a tolerably uniform composition, the average of all the percentages of nitrogen being 2.02 per cent., nearly identical with the percentage reported in the first analysis.

Bone Manures Sampled by Manufacturers and by Purchasers.

In the table on pp. 40 and 41 are given analyses of sixteen samples of bone, which were sent by purchasers, and of one sample deposited by a manufacturer representing a brand which was not found in market by our sampling agent.

The Station is responsible for the correct subdivision and analysis of the small samples placed in its possession, but not for the accuracy with which those samples represent the several articles specified,—though it requires that a certificate be filed by the person drawing the sample, stating that it has been fairly drawn according to the printed directions furnished by the Station.

BONE MANURES. SAMPLED BY 

Station No.	Name or Brand.	Manufacturer.
10544	Ground Bone.	E. C. Dennis, Stafford Springs.
10240	Preston's Ground Bone.	Preston Fert. Co., Greenpoint, L. I.
10281	Ground Bone.	Berkshire Mills Co., Bridgeport.
10753	Ground Bone.	Lowell Fertilizer Co., Boston.
10754	Ground Bone.	Lowell Fertilizer Co., Boston.
10255	Armour's Bone Meal.	Armour Fertilizer Works, Chicago.
10546	Ground Bone Meal.	Crocker Fertilizer Co., Buffalo, N. Y.
10541	Pure Ground Bone.	G. W. Miller, Middlefield.
10723	Bone Meal.	Milsom Rend. & Fert Co., E. Buffalo.
10543	Fine Ground Bone.	L. B. Darling Fertilizer Co., Pawtucket.
10830	Lowell Ground Bone.	Lowell Fertilizer Co., Boston, Mass.
10430	Fine Ground Bone.	L. Sanderson, New Haven.
10569	Ground Bone.	Lowell Fertilizer Co., Boston.
10827	Lowell Ground Bone.	Lowell Fertilizer Co., Boston.
10307	Pure Raw Bone Meal.	Listers Agricultural Chem. Works, Newark, N. J.
10264	Fine Ground Bone.	L. Sanderson, New Haven.
10826	Lowell Ground Bone.	Lowell Fertilizer Co., Boston.
10395	Hubbard's Pure Raw Knuckle Bone Flour.	Rogers & Hubbard Co., Middletown.
10829	Lowell Ground Bone.	Lowell Fertilizer Co., Boston.
10825	Lowell Ground Bone.	Lowell Fertilizer Co., Boston.
10828	Lowell Ground Bone.	Lowell Fertilizer Co., Boston.
10303	Ground Bone.	Hartford Fertilizer Co., Hartford.
10389	Ground Bone.	Wm. McCormack, Wolcott.
10282	Chittenden's Ground Bone.	National Fertilizer Co., Bridgeport.
10393	Fresh Ground Bone.	Bowker Fertilizer Co., Boston.
10397	Pure Ground Bone.	Peck Bros., Northfield.
10545	Hubbard's Strictly Pure Fine Bone.	Rogers & Hubbard Co., Middletown.
10277	Ground Bone.	Plumb & Winton Co., Bridgeport.
10740	Self-Recommending Fertilizer.	Successor to F. Nuhn, Waterbury.
10404	Pure Ground Bone.	Rogers Mfg. Co., Rockfall.
10398	Swift Sure Bone Meal.	M. L. Shoemaker, Philadelphia.
10306	Bone Meal.	M. E. Wheeler, Rutland, Vt.
10540	Bone Meal.	W. E. Brightman, Tiverton, R. I.
10399	Pure Bone Dust.	P. Cooper's Glue Factory, N. York.
10539	Pure Ground Bone.	Lederer & Wolf, New Haven.
10283	Ground Bone.	Downs & Griffin, Derby.
10388	Americus Pure Bone Meal.	Williams & Clark, New York.
10396	Bone Meal.	Quinnipiac Co., Boston.
10542	Cyclone Pure Bone Meal.	Milsom Rend. & Fert. Co., E. Buffalo.
10537	Fine Ground Bone.	Bradley Fertilizer Co., Boston.
10394	Fine Ground Bone.	Bradley Fertilizer Co., Boston.
10548	White Oak Pure Ground Bone.	Clark's Cove Fertz. Co., New York.
10722	Extra Fine Ground Bone.	Cumberland Bone Phos. Co., Boston.
10547	Fine Ground Bone.	Pacific Guano Co., Boston.

STATION AGENT. ANALYSES.

Dealer.	Dealers' cash price per ton.	Valuation per ton.	Percentage difference between cost and valuation.	Chemical Analysis.		Mechanical Analysis.	
				Nitrogen.	Phos. Acid.	Finer than $\frac{1}{160}$ inch.	Coarser than $\frac{1}{160}$ inch.
Manufacturer.	\$22.00	\$24.08	*8.6	4.29	21.16	13	87
O. G. Beard, Shelton.	25.00	26.38	*5.2	2.56	27.30	47	53
Manufacturer.	28.00	27.60	1.4	2.93	26.76	63	37
Standard Feed Co., Bridgeport.	28.00	27.61	1.4	2.02	29.44	68	32
Standard Feed Co., Bridgeport.	28.00	27.49	2.2	2.25	28.68	63	37
C. J. Benham, New Haven.	27.00	26.07	3.5	2.85	25.11	62	38
H. C. Porter, Hebron.	28.00	27.89	4.0	2.93	26.74	70	30
H. C. Aborn, Ellington.	30.00						
	29.00						
Manufacturer.	26.00	24.44	6.4	4.08	21.82	20	80
W. T. Anderson & Son, Tolland.	28.00	26.22	6.8	3.25	24.43	55	45
F. L. Hitchcock, Watertown.	30.00	27.45	9.3	3.27	25.32	66	34
A. I. Kinney, Terryville.	30.00						
S. R. Dean, Seymour.	30.00						
Manufacturer.	30.00	27.41	9.4	2.10	29.16	63	37
Bugbee Bros., Willimantic.	30.00	27.39	9.5	4.18	22.23	67	33
J. P. Barstow, Norwich.	32.00	27.26	10.0	2.03	29.31	61	39
A. A. Snow, Clinton.	30.00						
C. W. Lines, New Britain.	30.00						
M. D. Stanley, New Britain.	27.00	27.21	10.3	2.17	28.45	67	33
A. N. Clark, Milford.	28.00						
	27.50						
Manufacturer.	30.00	27.03	10.9	4.23	21.70	66	34
D. N. Clark, Shelton.	30.00	27.02	11.0	1.90	29.18	65	35
H. W. Andrews, Wallingford.	32.50	28.72	11.4	3.86	25.36	62	38
W. C. Bulkley, Forestville.	32.00						
City Coal & Wood Co., N. Brit'n	35.50						
Bugbee Bros., Willimantic.	30.00	26.90	11.5	2.23	28.29	60	40
C. N. Jones, Wallingford.	30.00	26.87	11.6	1.87	29.07	66	34
S. A. Billings, Meriden.	30.00	26.71	12.3	1.61	29.58	68	32
S. A. Billings, Meriden.	29.00	25.83	12.3	2.78	24.92	63	37
Manufacturer.	28.00	24.81	12.9	4.28	22.46	10	90
Manufacturer.	25.00	22.05	13.4	3.26	20.60	25	75
W. O. Gootsell, Bristol.	30.00	26.44	13.4	2.76	26.00	60	40
C. T. Leonard, Norwalk.	32.00						
W. H. Scott, Pequabuck.	28.00						
Apothecaries' Hall, Waterbury.	32.00	24.38	14.8	4.17	21.33	22	78
Manufacturer.	30.00	26.09	15.0	3.98	22.76	43	57
John Bransfield, Portland.	30.00						
Manufacturer.	28.00						
Manufacturer.	30.00	26.06	15.1	4.13	20.52	69	31
Manufacturer.	30.00	25.89	15.9	4.45	20.88	45	55
John Bransfield, Portland.	30.00						
Olds & Whipple, Hartford.	37.00						
J. F. Blakeslee, North Haven.	32.00	31.46	17.6	5.26	24.01	68	32
Wm. Crane, Broad Brook.	28.00	27.03	18.4	2.44	28.63	46	54
Apothecaries' Hall, Waterbury.	30.00	23.24	20.5	3.31	20.07	59	41
Edward White, Rockville.	30.00	24.71	21.4	1.61	27.90	50	50
Manufacturer.	30.00	24.50	22.4	2.48	25.01	48	52
Gault Bros., Westport.	30.00	24.41	22.9	1.90	25.97	62	38
Gault Bros., Westport.	30.00	23.71	26.5	2.72	22.20	66	34
H. S. Coe, Harwinton.	32.00	24.47	26.7	3.07	22.18	64	36
	31.00						
G. W. Barnes, Poquonock.	35.00						
P. Schwartz, Chesterfield.	32.00	26.54	31.9	3.70	23.14	60	40
S. A. Billings, Meriden.	33.00	23.84	34.2	2.90	22.13	60	40
C. O. Jelliff, Southport.	29.00	23.07	38.7	2.62	21.59	68	32
	32.00						
J. R. Ballard, Thompson.	30.00						
L. J. Storrs, Mansfield Center.	32.00	21.42	40.0	3.06	18.43	60	40
Jas. W. Nichols, Danielson.	30.00	19.39	65.0	2.40	17.78	62	38
	30.00	18.12	65.6	1.98	17.37	64	36

BONE MANURES, SAMPLED BY MANUFACTURERS (1898)

Station No.	Name or Brand.	Manufacturer or Dealer.
10715	Pure Ground Bone.	Crocker Fertilizer Co., Buffalo, N. Y.
10132	Bone.	Mr. Davis, Rocky Hill, Conn.
10148	Bone.	
10156	Bone.	Swift & Co., Chicago, Ill.
10178	Pure Raw Bone.	The Scientific Fertilizer Co., Pittsburg, Pa.
10192	Nuhn's Self-recommending Fertilizer, made in summer, 1897.	Successor to F. Nuhn, Waterbury.
10193	Nuhn's Self-recommending Fertilizer, made in winter, 1897-'98.	Successor to F. Nuhn, Waterbury.
10226	Bone Fertilizer.	Plumb & Winton Co., Bridgeport.
10238	Raw Wet Butchers' Bone.	
10275	Fine Ground Bone.	Bradley Fertilizer Co., Boston.
10295	Fine Ground Bone.	Bowker Fertilizer Co., Boston.
10309	Fresh Ground Bone.	Bowker Fertilizer Co., Boston.
10461	Pure Ground Bone.	National Fertilizer Co., Bridgeport.
10478	Fresh Ground Bone.	Bowker Fertilizer Co., Boston.
10508	Darling's Ground Bone.	W. W. Cooper, Suffield.
10644	Ground Raw Bone.	George F. Taylor's Sons, New York City.
10840	Strictly Pure Raw Bone.	M. E. Wheeler & Co., Rutland, Vt.

AN EXPERIMENT IN TREATING RAW BONE WITH SULPHURIC ACID.

Mr. C. M. Jarvis of East Berlin had a quantity of raw, wet butcher's bone cut up for poultry good. This treatment left it still very coarse for use as a fertilizer, and being very damp, and full of grease, milling it was out of the question. It has been proposed to treat raw bone with oil of vitriol in quantity only sufficient to convert the phosphoric acid into the dibasic combination ("reverted" phosphoric acid), an operation which is said to greatly increase its availability. This plan was tried with a small lot of this coarse, wet bone, hoping by the means to improve its mechanical condition as well as the availability of the phosphoric acid. Accurate sampling of the treated and untreated bone were, under the circumstances, not possible, but the analyses may serve to show the general effect of the treatment.

Forty pounds of concentrated oil of vitriol, 66°B, were

OR BY PURCHASERS. ANALYSES.

Station No.	Sampled by	Dealers' cash price per ton.	CHEMICAL ANALYSIS.			MECHANICAL ANALYSIS.	
			Valuation per ton.	Nitrogen.	Phos. Acid.	Fine, smaller than $\frac{1}{60}$ inch.	Coarse, larger than $\frac{1}{60}$ inch.
10715	Manufacturer.	.....	\$27.96	3.88	26.12	36	6
10132	Butler & Jewell, Cromwell.	.....	20.05	3.62	18.18	2	9
10148	C. M. Jarvis, Berlin, Conn.	\$13.50*	21.14	3.50	20.16	1	9
10156	C. M. Jarvis, Berlin, Conn.	24.50*	26.87	4.00	24.66	31	69
10178	H. B. Buell, Eastford.	29.00	26.56	3.72	23.63	52	48
10192	A. H. Coe, Waterbury.	.....	27.38	4.79	20.92	58	42
10193	A. H. Coe, Waterbury.	.....	26.99	4.32	22.04	56	44
10226	F. L. Staples, Plattsville.	.....	25.63	3.96	22.20	43	57
10238	C. M. Jarvis, Berlin.	.....	.....	2.87	18.71	.....	.....
10275	M. C. Knapp, Danbury.	31.00	22.34	3.04	19.96	55	45
10295	J. P. O'Connor, Wethersfield	27.00	25.81	2.68	25.89	52	48
10309	W. H. Olcott, Manchester.	28.00	26.83	3.08	26.15	49	51
10461	E. C. Warner, Fair Haven.	25.00	21.66	3.24	18.86	47	53
10478	N. S. Gallup, Ledyard.	28.00	23.98	2.94	21.63	70	30
10508	Jos. Frohlinger, Jr., Suffield.	30.00	25.39	2.70	24.05	73	27
10644	H. C. C. Miles, Milford.	22.00	27.57	3.34	24.88	72	28
10840	G. H. Pearson, Bethel.	32.00	26.95	2.42	27.30	70	30

poured into an oil cask over 265 pounds of the raw, wet bone above described, which contained

Nitrogen,	.	.	.	.	2.87
Water-soluble Phosphoric Acid,	.	.	.	.	.31
Citrate-soluble	"	"	.	.	10.85
Insoluble	"	"	.	.	8.05
Total	"	"	.	.	19.21
Water,	.	.	.	.	25.23
Grease,	.	.	.	.	21.54

The whole mass became hot and boiled, the sulphuric acid drawing water from the bone. It was stirred and mixed as thoroughly as was possible and allowed to stand for some days, when it was weighed, and a sample sent to the Station for analysis.

* Car lot, f. o. b. E. Berlin.

There resulted 270 pounds of a mixture, No. 10237, containing

Nitrogen,	3.50 per cent.
Water-soluble Phosphoric Acid, .	2.85 "
Citrate-soluble Phosphoric Acid, .	12.88 "
Insoluble Phosphoric Acid, .	3.22 "
Total Phosphoric Acid, .	18.95 "

Reckoning the number of pounds of nitrogen and phosphoric acid from these percentages, we have the following comparison :

	The raw bone contained	The acidified bone contained
Nitrogen,	7.6 pounds.	9.5 pounds.
Water-soluble Phosphoric Acid, .8	"	7.7 "
Citrate-soluble Phosphoric Acid, 27.4	"	34.8 "
Insoluble Phosphoric Acid, . 21.3	"	8.7 "
Total Phosphoric Acid, . 49.5	"	51.2 "

It is probable that the raw bone did not contain as much citrate-soluble phosphoric acid as the analysis shows, for in order to bring the sample into condition for analysis it was necessary to dry a weighed portion and partially extract the grease. The analysis was made on this dried material and reckoned back to the fresh material. But this fresh bone would have certainly been less soluble in citrate solution than it was after drying and extraction.

The number of pounds of nitrogen and of total phosphoric acid should have been the same in the raw and in the dissolved bone, and the discrepancy is to be explained by the impossibility, under the circumstances, of getting a perfectly representative sample.

The results, however, show that more than half of the "insoluble" phosphoric acid of the raw bone was converted into soluble forms, the whole mass was dried, both by evaporation due to the great heat evolved (305 pounds of bone and acid lost 35 pounds during treatment) and by the "fixation" of water by calcium sulphate formed by the reaction of sulphuric acid and lime. Besides this, the material was made finer in its mechanical condition and further putrefaction was checked.

This method, which may be recommended for bone which has been cut or crushed into small pieces, is not applicable, probably, to coarse, raw bones, which offer a comparatively small surface to the action of oil of vitriol.

TANKAGE.

After boiling or steaming meat scrap, bone, and other slaughter-house waste, fat rises to the surface and is removed, the soup is run off, and the settlings are dried and sold as tankage. As analyses show, tankage has a very variable composition. In general, it contains more nitrogen and less phosphoric acid than bone.

In the table, pages 44 and 45, are given thirteen analyses of this material, five drawn by a Station agent and eight by purchasers.

These analyses show the usual differences in chemical composition.

Some question having been raised as to the quality of Tankage No. 10311, the pepsin-solubility of its nitrogen was determined and found to be 63.6 per cent., thus demonstrating the absence of any considerable amount of agriculturally inferior nitrogenous matter.

TANKAGE. (☞)

Station No.	Name or Brand.	Dealer.
	<i>Sampled by Station Agent.</i>	<i>Dealer.</i>
10258	Blood and Meat.	E. E. Burwell, New Haven.
10459	Tankage.	Clifton Peck, Yantic.*
10267	Blood, Bone, and Meat.	L. Sanderson, New Haven.
10265	Pulverized Bone and Meat.	L. Sanderson, New Haven.
10246	Tankage.	S. D. Woodruff & Sons, Orange.*
	<i>Sampled by Purchaser.</i>	
10181	Tankage.	
10311	Tankage.	Bowker Fertilizer Co., Boston, Mass.
10243	Tankage.	
10153	Tankage.	Sperry & Barnes, New Haven.
10227	Tankage.	Plumb & Winton Co., Bridgeport.
10374	Bone Tankage.	Plumb & Winton Co., Bridgeport.
10204	Tankage.	Berkshire Mills Co., Bridgeport.
10511	Tankage.	Berkshire Mills Co., Bridgeport.

DRY GROUND FISH.

This residue from the manufacture of fish oil is often sprinkled with diluted oil of vitriol, to hinder decay during drying, whereby the fish bones are softened and to some extent dissolved.

Six analyses of this article are given in the table below.

With a single exception, the nitrogen found in these samples is well above the seller's guarantee.

DRY GROUND FISH. (☞)

Station No.	Manufacturer or Wholesale Dealer.	Sampled from Stock of	Dealer's Cash Price per Ton.
10719	Wm. E. Brightman, Tiverton, R. I.	William Crane, Broad Brook,	\$28.00
10720	Williams & Clark, New York, . .	Daniels Mills Co., Hartford,	29.00
10716	Quinnipiac Co., Boston, . . .	Olds & Whipple, Hartford,	30.00
10558	Wilcox Fertilizer Works, Mystic,	Manufacturer, . . .	30.00
		C. M. Smith, East Hartford,	31.00
10717	Luce Bros, Niantic, . . .	W. C. Reynolds, E. Haddam,	32.00
10718	Bowker Fertilizer Co., Boston, .	E. F. Miller, Ellington, .	28.00

* Purchaser only.

ANALYSES AND VALUATIONS.

Sampled from Stock of	Dealer's cash price per ton.	Valuation per ton.	Percentage diff. between Cost and Valuation.	CHEMICAL ANALYSIS.		MECHANICAL ANALYSIS.	
				Nitrogen.	Phosphoric Acid.	Fine, smaller than $\frac{1}{60}$ inch.	Coarse, larger than $\frac{1}{60}$ inch.
E. E. Burwell, New Haven.	\$29.00	\$26.29	10.3	9.86	4.04	51	49
Clifton Peck, Yantic.	24.00	19.72	21.7	5.38	8.44	66	34
L. Sanderson, New Haven.	30.00	23.77	26.2	5.68	12.51	70	30
L. Sanderson, New Haven.	34.00	26.34	29.1	4.90	18.55	67	33
S. D. Woodruff & Sons, Orange.	.....	23.41	....	5.53	14.60	40	60
C. M. Jarvis, Berlin.	12.50†	22.62	44.7†	7.38	9.34	19	81
Fred R. Jennings, Greenfield Hill.	13.00	16.43	20.9†	5.12	4.99	66	34
J. G. Schwink, Jr., Meriden.	20.00	25.16	20.5†	7.51	9.75	53	47
F. T. Bradley, Saybrook.	21.00	23.36	10.1†	8.33	4.06	62	38
F. L. Staples, Plattville.	25.00	22.91	9.1	5.40	13.16	57	43
D. Fenn & Son, Milford.	25.00	22.24	12.4	4.90	13.48	63	37
S. E. Curtis, Stratford.	.....	24.03	...	6.15	13.07	46	54
E. Manchester & Sons, West Winsted.	.....	26.80	....	9.46	4.77	64	36

MIXED FERTILIZERS.

BONE AND POTASH AND BONE AND WOOD ASHES.

10582. Bone and wood ash fertilizer, made by Bowker Fertilizer Co., Boston, Mass. Stock of S. E. Brown, Collinsville, and A. L. Hitchcock, Plainville.

10704. Ground bone and potash, made by The E. F. Coe

ANALYSES AND VALUATIONS.

Valuation per Ton.		Percentage Difference between Cost and Valuation.		NITROGEN.						PHOSPHORIC ACID.					
		Nitrogen as Ammonia.	Or Nitrogen, ganic.	Tot. Nitrogen.			Reverted.	Insoluble.	Total.		Available.				
				Found.	Guaran- teed.	Soluble.			Found.	Guaran- teed.	Found.	Guaran- teed.			
\$29.64	5.5†	.22	8.42	8.64	7.4	.59	5.21	1.84	7.64	7.0	5.80	...			
30.51	4.9†	.32	8.74	9.06	7.4	.94	4.56	1.61	7.11	7.0	5.50	...			
30.55	1.8†	.30	8.90	9.20	7.7	.70	4.36	1.67	6.73	7.0	5.06	...			
30.22	0.7†	.20	8.72	8.92	8.5	.61	4.83	2.07	7.51	6.0	5.44	...			
		29.83	7.3	1.50	6.86	8.36	8.2	.93	6.48	1.00	8.41	...	7.41	...	
20.47	36.8	.34	5.36	5.70	6.6	1.22	3.62	1.28	6.12	6.0	4.84	...			

‡ Car lot price.

† Valuation exceeds cost.

Fertilizer Co., New York city. Stock of Gault Bros., Westport.

10705. Bone and potash, made by Lister's Agricultural Chemical Works, Newark, N. J. Stock of A. W. Hutchinson, Gilead, and W. B. Martin, Rockville.

ANALYSES AND VALUATIONS.

	10582	10704	10705
Nitrogen of Nitrates,	0.73	....	....
Nitrogen, organic,	1.24	2.05	....
Nitrogen, total,	1.97	2.05	....
Soluble Phosphoric Acid, . . . . .	....	....	5.28
Reverted Phosphoric Acid,	8.11	....	3.01
Insoluble Phosphoric Acid,	4.95	....	0.58
Total Phosphoric Acid,	13.06	17.31	8.87
Potash as Muriate,	1.13	2.55	5.23
Potash as Sulphate,	1.27	....	....
Potash total,	2.40	2.55	5.23
Cost per ton,	\$25.10	28.00	24.00
Valuation per ton,	\$16.07	20.09	11.84

The potash in sample **10582** is stated to be from wood ashes. The sample contained some chlorine, and a corresponding quantity of potash has therefore been reckoned as muriate, following the practice noted on page 18. The potash is probably present chiefly in the form of carbonate.

Sample **10705** does not contain bone, but is a mixture of dissolved phosphate and potash salts.

NITROGENOUS SUPERPHOSPHATES AND GUANOS.

Here are included those mixed fertilizers containing nitrogen, phosphoric acid, and in most cases, potash, which are not designed by their manufacturers for use on any special crop. "Special Manures" are noticed further on.

1. *Samples drawn by Station Agents.*

In the tables on pages 50 to 61 are given analyses of 119 samples belonging to this class, arranged according to the percentage differences between their cost prices and valuations.

GUARANTEES.

Of the one hundred and nineteen analyses of nitrogenous superphosphates given in the tables, twenty-three are below the manufacturer's minimum guarantee, in respect of one ingredient, and three in respect of two ingredients

The number which failed to come up to the guarantee is relatively about the same as in the previous year.

There are only seven failures to meet the guarantee on nitrogen, the most costly ingredient, and eight failures in phosphoric acid; but in five of these the failure is in total phosphoric acid, while the "available" phosphoric acid is well above the guarantee. There are sixteen failures to meet the guaranteed percentage of potash. The larger number of these are probably explained by the difficulty of securing uniform mixture of the potash salts and the use of the foreign analyses of potash salts in calculating formulas for mixtures. These analyses do not always fairly represent the goods, after the vicissitudes of ocean freighting, lightering, and storage.

Usually the deficiency of one ingredient in the mixture has been made up by a surplus of another, indicating that the lack of agreement between actual and guaranteed composition was caused by defects in mixing or by a mechanical separation of the ingredients after mixing.

COST AND VALUATION.

Cost.

The method used to ascertain the retail cost price of the superphosphates is as follows:

The sampling agents inquire and note the price at the time each sample is drawn. The analysis, when done, is reported to each dealer from whom a sample was taken, with an enclosed postal card addressed to the Station, and a request to note on it whether the retail cash price is correctly given and to mail to the Station.

From the data thus obtained the average prices are computed.

Valuation.

The valuation has been computed in all cases in the usual manner as explained on page 18.

Percentage difference given in the table shows the percentage excess of the cost price over the average retail cost of the

nitrogen, phosphoric acid, and potash contained in the fertilizer.

This information enables the purchaser to estimate the comparative value of different brands and to determine whether it is better economy to buy the commercial mixed fertilizers of which so many are now offered for sale, or to purchase and mix for himself the raw materials.

Which plan is preferable can only be determined by each individual farmer, who should know best what his soil and crops need and what his facilities for purchase and payment are.

In case a fertilizer has sold at two or more different prices, the *manufacturer's price*, when known, has been used in calculating percentage difference.

Otherwise an *average, or nearly average price*, forms the basis of comparison between cost and valuation. The price thus employed is printed in heavy-faced type.

The average cost of the nitrogenous superphosphates is \$29.22. The average valuation is \$19.30, and the percentage difference 51.4.

Last year the corresponding figures were:

Average cost \$30.44, average valuation \$20.75, percentage difference 46.9.

These valuations, it must be remembered, are based on the assumption that the nitrogen, phosphoric acid, and potash in each fertilizer are of good quality and readily available to farm crops. Chemical examination shows conclusively whether this is true in respect of potash and phosphoric acid, but gives little or no clue as to the availability of the organic nitrogen of mixed goods. This Station has been for some years, and is still, engaged in a study of methods for determining approximately the relative availability of nitrogen.

Since various inferior or agriculturally worthless forms of nitrogen are in the market and are known to be used in compounding fertilizers, and cannot as yet be detected with certainty by analysis, the only security of purchasers of mixed fertilizers is in dealing with firms which have the highest reputation and are able to satisfy their customers that they use the best raw materials, and in avoiding "cheap" goods offered by irresponsible parties.

Analyses Requiring Special Notice.

10407. E. Frank Coe's Long Islander Market Garden Special, page 50, is not on sale by agents in this State, but is sold direct from the factory to farmers in certain districts.

The manufacturer states that the analysis given on pp. 50 and 51 does not fairly represent the average quality of this brand, which should never show less than 9.5 per cent. of available phosphoric acid.

10390. Fairchild's Formula for Corn and General Crops, made by the Rogers & Hubbard Co., Middletown. The analysis, page 50, was made on a mixture of two samples. The one from stock of Mr. Kilbourne, we were informed, after making the analysis, represented stock carried over from last year.

10559. Fish and Potash, made by The Rogers Manufacturing Co., is below the guarantee in nitrogen, page 54. At the request of the manufacturers, another sample was drawn, **10735**, page 52, which contained a much higher percentage of nitrogen.

10419. Farmers' New Method, made by The Bradley Fertilizer Co., Boston, Mass., page 54. The percentage of potash being below the guarantee, other samples were drawn at the request of the manufacturer, and analysis **10729**, page 54, was made on a mixture of them. This contained the guaranteed amount of potash.

10685. Gold Brand Excelsior Guano, made by The E. Frank Coe Co., New York city. Sampled from stock of Edgar Brewer & Son, Hockanum. See pp. 60 and 61. The manufacturer stated that this sample did not fairly represent the average quality of the brand, which should contain about 6.3 per cent. of potash, and requested that other samples be drawn. Accordingly a sample was drawn from stock of L. C. Grant, Talcottville, the only dealer who had any of the goods on hand in July.

The analysis **10772**, pp. 56 and 57, show 5.02 per cent. of potash, while the first analysis showed but 4.73 per cent.

Inferior Forms of Nitrogen.

The analysis **10445**, given in the tables, p. 60, is of a Fertilizer, made by the Connecticut Reduction Co., of Bridgeport. This fertilizer is stated to be made in part, at least, of city garbage. The tests made on other samples, which are described on page 62, make it quite probable that the nitrogen of this material is of very inferior value as plant food. For this reason no "valuation" is given.

NITROGENOUS SUPERPHOSPHATES AND GUANOS, SAMPLED BY THE STATION.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.
10340	Buckingham XX Formula.	C. Buckingham, Southport.	Manufacturer.	\$30.00
10684	Fertilizer.	Conn Valley Orchard Co., Berlin.	Manufacturer.	25.00
10626	Manchester's Formula.	E. Manchester & Sons, West Winsted.	R. D. Wilson, Winsted. Manufacturer.	29.00 } 29.00 }
10708	Harvest Home Fertilizer.	H. J. Baker & Bro., N. Y.	W F. Andross, E. Hartf'd	25.00
10407	Long Islander Market Garden Special.*	E. Frank Coe, New York.	G. S. Jennings, Southport	28.00
10602	Complete Fertilizer for Potatoes and Gen'l Crops	F. E. Boardman, Little River.	Manufacturer.	28.00
10742	Bone, Fish, and Potash.	E. R. Kelsey, Branford.	Loomis Bros., Granby.	24.00
10650	Complete Manure.	Standard Fert Co., Boston	E. M. Olmsted, Chester.	28.00
10391	Pure Fine Bone Dissolved in Sulphuric Acid.	Mapes F. & P. G. Co., New York.	Mapes Branch, Hartford. C. W. Atwood, Water-town.	29.00 } 31.00 } 30.00 }
10390	Fairchild's Formula for Corn and Gen'l Crops.*	The Rogers & Hubbard Co., Middletown, Conn	City Coal & Wood Co., New Britain. A. E. Kilbourne, E. Hartford.	44.00
10646	Hubbard's All Crops, All Soils.	The Rogers & Hubbard Co., Middletown.	John Bransfield, Portland J. P. Barstow, Norwich.	28.00 } 28.00 }
10695	Unexcelled Phosphate.	G. W. Miller, Middlefield.	Manufacturer.	30.00
10452	Ammoniated Bone with Potash.	Armour Fertilizer Works, Chicago.	C. J. Benham, N. Haven Wilson & Burr, Middle-town.	25.00 } 28.00 } 26.50 }
10474	Bone, Fish, and Potash.	Luce Bros., Niantic.	Cromwell Co-operative Store, Cromwell. Manufacturer.	29.00 } 24.00 }
10743	Fisherman's Brand Fish and Potash.	Bowker Fertilizer Co., Boston.	F. A. Beckwith, Niantic. P. Schwartz, Chesterfield. F. T. Bradley, Saybrook. G. F. Walters, Guilford. Bowker's Branch, Hartford. W. H. Todd, No. Haven.	25.00 } 25.00 } 25.00 } 24.00 } 26.00 } 18.00 }
10460	Middlesex Special.	Bowker Fert. Co., Boston.	W. H. Baldwin, Meriden.	25.00
10653	Bay State Special.	H. F. Tucker & Co., Boston	Alfred Snider, Rockville.	32.00
10447	Market Garden.	Bowker Fertilizer Co., Boston.	W H Todd, No. Haven. Peck Bros, West Cheshire.	32.00 } 32.00 } 36.00 } 33.00 }
10519	All Soluble.	Armour Fertilizer Works, Chicago.	Adams & Canfield, Winthrop. E. W. Buck, Willimantic.	30.00 } 33.00 }
10667	Pequot Fish and Potash.	Quinnipiac Co, Boston.	A. J. Martin, Wallingford.	31.50
10617	Animal Fertilizer.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	A. I. Kinney, Terryville. Hotchkiss & Templeton, Waterbury.	30.00 } 34.00 } 32.00 }
10614	Blood, Bone, and Potash.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	Loomis Bros., Granby. Hotchkiss & Templeton, Waterbury.	35.00 } 37.00 } 36.00 }
10581	Complete Fertilizer.	Berkshire Mills Co., Bridgeport.	Johnson Bros., Jewett City. A. C. Taintor, Colchester.	31.00 } 35.00 }
10641	G. G. Bay State Fertilizer.	Clark's Cove Fert. Co., N. Y.	Manufacturer. H. E. Daniels, N. London.	32.00 } 24.00 }

ANALYSES—*Continued.*

Valuation per ton.	Percentage difference between cost and valuation.	NITROGEN.					PHOSPHORIC ACID.					POTASH.				
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Total Nitrogen.		Reverted.	Insoluble.	Total.		Available.		Found.			
					Found.	Guaranteed.			Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.	
\$28.87	3.9	1.25	...	3.17	4.42	4.16	0.05	3.74	1.42	11.21	10.0	9.79	5.0	0.55	7.81	6.0
23.39	6.9	1.29	...	2.94	4.23	4.16	0.21	3.29	2.30	11.80	..	9.50	9.0	3.14	3.14	3.0
26.26	10.4	0.70	...	3.47	4.17	3.56	0.30	1.42	0.24	7.96	7.5	7.72	...	3.92	8.40	8.0
22.22	12.5	4.21	...	1.22	5.43	1.04	0.30	1.86	1.22	7.38	9.0	6.16	8.0	2.35	2.35	2.0
24.11	16.1	..	0.90	2.55	3.45	3.57	0.10	1.42	1.66	10.18	11.0	8.52	9.0	0.52	6.34	6.0
23.92	17.1	...	...	3.00	3.00	2.56	0.22	1.83	0.28	8.33	...	8.05	7.0	9.82	9.82	10.0
20.18	18.9	...	0.54	3.18	3.72	3.32	0.94	2.63	0.67	6.24	4.0	5.57	...	0.59	4.84	4.0
22.98	21.8	1.26	...	2.06	3.32	3.34	0.38	3.81	1.40	9.59	9.0	8.19	8.0	7.50	7.50	7.0
23.99	25.0	...	...	2.91	2.91	2.13	0.68	13.63	4.08	21.39	12.0	17.31	..	...	...	...
34.90	26.1	3.37	...	2.25	5.62	5.5	...	...	...	13.34	12.0	...	...	12.41	12.41	12.5
21.81	28.4	0.92	...	1.94	2.86	2.37	0.33	4.48	1.89	13.70	12.0	11.81	10.0	3.59	3.59	3.0
23.16	29.5	...	...	2.71	2.71	2.04	0.82	3.97	1.64	10.43	10.5	8.79	...	8.69	8.69	9.0
20.45	29.6	...	...	3.00	3.00	2.52	0.02	6.15	3.79	11.96	8.0	8.17	6.0	0.55	3.87	3.0
18.46	30.0	...	1.00	2.31	3.31	3.02	0.06	3.06	0.70	5.82	4.0	5.12	...	1.47	4.83	4.0
18.32	31.0	...	0.14	2.50	2.64	2.33	0.61	2.41	3.37	9.39	6.0	6.02	4.0	5.18	5.18	5.0
19.05	31.2	...	...	2.41	2.41	2.14	0.85	2.95	1.60	9.40	8.0	7.80	...	5.80	5.80	6.0
24.09	32.8	0.89	..	2.55	3.44	3.32	0.88	6.14	2.35	11.37	9.0	9.02	8.0	7.29	7.29	7.0
24.74	33.4	0.64	...	2.28	2.92	2.34	0.99	1.87	1.15	8.01	8.0	6.86	6.0	12.06	12.06	10.0
23.59	33.5	...	0.62	2.87	3.49	2.93	0.52	5.94	1.50	10.96	10.0	9.46	8.0	0.29	5.33	4.0
16.26	35.3	...	0.32	2.57	2.89	2.11	0.73	4.14	3.33	9.20	7.0	5.87	6.0	2.30	2.30	2.0
23.26	37.6	0.32	...	3.72	4.04	3.34	0.16	5.37	0.96	10.49	10.0	9.53	6.0	4.22	4.22	4.0
26.09	38.0	0.63	0.28	3.13	4.04	4.54	0.74	5.18	0.52	10.44	9.0	9.92	7.0	7.40	7.40	7.0
23.13	38.3	0.67	0.12	2.11	2.90	2.55	0.73	4.73	1.22	11.68	10.0	10.46	8.0	6.72	6.72	6.0
17.20	39.5	...	..	2.22	2.22	1.96	0.05	3.89	1.47	11.41	10.0	9.94	8.5	2.15	2.15	2.0

NITROGENOUS SUPERPHOSPHATES AND GUANOS, SAMPLED BY THE STATION.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.
10679	Concentrated Phosphate.	Cumberland Bone Phosphate Co., Boston.	Kahn Bros., Yantic.	\$34.00
10706	Old Reliable Superphosphate.	L. Sanderson, New Haven	R. M. Goodale, Durham.	30.00
			A. B. Morse & Son, Guilford.	28.00
10697	Cecrops.	Fred'k Ludlam, N. York.	S. A. Smith, Clintonville.	29.00
10472	Complete Manure for Light Soils.	Mapes F. & P. G. Co., New York.	Mapes Branch, Hartford.	34.00
10712	Anchor Brand Fish and Potash.	Bradley Fertilizer Co., Boston.	J. P. Barstow, Norwich.	39.00
10628	Ammoniated Bone Superphosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	Manufacturer.	40.00
			Latimer & Williams, So. Coventry.	27.00
10608	Market Garden Manure.	Lowell Fertilizer Co., Boston.	Smith & Sons, West Cornwall.	31.00
			W. D. Penfield, Cobalt.	25.00
			N. N. King, Thompsonville.	28.00
			J. F. Sheridan & Bro., Manchester.	40.00
10423	Market Garden Manure.	Quinnipiac Co., Boston.	C. Buckingham, Southport.	39.00
			Gault Bros., Westport.	33.00
10663	High Grade Farm's Friend	Read Fertilizer Co., N. Y.		36.00
10449	Gardeners' Complete Manure.	Packer's Union Fertilizer Co., New York.	B. H. Saunder, Collinsville.	34.50
			A. S. Bennett, Cheshire.	36.00
			Walter Gildersleeve, Gildersleeve.	35.00
10707	Swift Sure Superphosphate for General Use.	M. L. Shoemaker & Co., Philadelphia.	J. P. Barstow, Norwich.	36.00
			Daniels Bros., Middletown.	35.00
			W. W. Cooper, Suffield.	35.00
			Olds & Whipple, Hartford.	35.00
10689	High Grade Complete Manure.	Cleveland Dryer Co., Boston.	C. E. Main, Plainfield.	35.00
10735	Fish and Potash.*	Rogers Mfg. Co., Rockfall, Conn.	Manufacturer.	34.00
10568	High Grade Fish and Potash.	Wilcox Fertilizer Works, Mystic.	W. A. Howard, Woodstock.	29.00
			Manufacturer.	30.00
			I. W. Dennison, Mystic.	27.00
10732	Market Garden Manure.	Quinnipiac Co., Boston.	Osborn & Co., Branford.	35.00
			O. S. Olmsted, Melrose.	34.00
				34.50
10699	Animal Fertilizer, G Brand	L. B. Darling Fertilizer Co., Pawtucket.	Hotchkiss & Templeton, Waterbury.	32.00
10670	High Grade Gen. Fertilizer.	Pacific Guano Co., Boston.	J. A. Nichols, Danielson.	34.00
10484	Essex XXX Fish and Potash.	Russia Cement Co., Gloucester, Mass.	C. N. Jones, Wallingford.	28.00
			L. A. Carrier, Berlin.	30.00
				29.00
10620	Vegetable Bone Fertilizer.	Milsom Rend. and Fertilizer Co., East Buffalo, N. Y.	D. E. Doolittle, West Cheshire.	36.00
			G. W. Barnes, Poquonock.	32.00
10579	Standard U. X. D. Fertilizer.	H. J. Baker & Bro., N. Y.	I. J. Scoville, Plainville.	34.00
10616	Dissolved Bone and Potash.	L. B. Darling Fertilizer Co., Pawtucket.	Hotchkiss & Templeton, Waterbury.	25.00
			F. L. Hitchcock, Waterbury.	36.00
				38.00
				37.00

ANALYSES—*Continued.*

Valuation per ton.	Percentage difference between cost and valuation.	NITROGEN.						PHOSPHORIC ACID.						POTASH.			
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.		Guaranteed.	
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.		
\$24.32	39.8	0.89	...	2.51	3.40	3.3	2.88	6.69	2.20	11.77	11.0	9.57	8.0	7.25	7.25	7.0	
20.67	40.3	0.20	0.16	2.32	2.68	2.0	3.94	6.84	3.16	13.94	10.0	10.78	7.0	3.44	3.44	2.0	
24.21	40.4	1.29	...	2.18	3.47	3.0	6.98	2.48	1.00	10.46	...	9.46	7.0	7.17	7.17	7.0	
27.71	40.7	0.68	1.10	3.74	5.52	4.9	2.24	4.38	1.80	8.42	8.0	6.62	6.0	7.23	7.23	6.0	
19.09	41.4	...	...	3.60	3.60	3.3	2.91	3.37	1.46	7.74	5.0	6.28	3.0	3.13	3.58	3.0
19.70	42.1	...	...	3.17	3.17	2.9	7.01	3.96	0.70	11.67	...	10.97	10.0	1.25	1.25	1.1
27.31	42.8	...	0.84	4.06	4.90	4.1	6.29	0.98	0.35	7.62	8.0	7.27	7.0	0.49	7.08	6.0	
24.14	42.9	0.68	1.04	1.74	3.46	3.3	4.58	4.93	1.80	11.31	9.0	9.51	8.0	6.83	6.83	7.0	
25.18	43.0	...	0.42	3.02	3.44	3.3	4.16	2.16	1.00	7.32	6.0	6.32	...	11.38	11.38	10.0	
24.46	43.1	...	...	2.74	2.74	2.5	6.75	2.08	1.07	9.90	...	8.83	8.0	1.27	8.81	10.0
24.44	43.2	0.89	...	1.97	2.86	2.5	9.38	3.15	1.90	14.43	...	12.53	...	0.09	4.90	4.0	
23.67	43.6	1.24	...	2.18	3.42	3.3	4.53	4.10	1.44	10.07	9.0	8.63	8.0	7.54	7.54	7.0	
19.48	43.7	..	0.38	2.84	3.22	3.3	1.97	4.64	2.64	9.25	6.0	6.61	...	4.62	4.62	3.8	
20.07	44.5	...	0.40	3.32	3.72	3.3	3.54	2.42	0.65	6.61	6.0	5.96	6.0	5.01	5.01	4.0	
23.77	45.1	1.68	...	1.78	3.46	3.3	3.66	5.01	1.88	10.55	10.0	8.67	8.0	7.49	7.49	7.0	
21.95	45.8	...	0.22	3.00	3.22	2.0	3.42	6.87	1.35	11.64	7.0	10.29	5.0	4.48	4.48	4.0	
23.27	46.1	1.88	...	1.56	3.44	3.3	4.39	4.12	1.51	10.02	9.0	8.51	...	7.25	7.25	7.0	
19.77	46.7	...	...	2.68	2.68	2.1	6.16	4.34	3.55	14.05	12.0	10.50	...	2.16	2.16	2.3
23.09	47.2	...	...	3.86	3.86	4.1	6.86	1.69	1.20	9.75	9.0	8.55	8.0	5.03	5.03	5.0
16.97	47.3	0.26	0.98	1.01	2.25	1.9	5.10	3.73	1.98	10.81	9.0	8.83	8.0	2.78	2.78	2.3	
25.04	47.8	0.06	0.26	2.10	2.42	1.5	5.55	7.61	0.90	14.06	13.0	13.16	11.0	8.02	8.02	7.0	

NITROGENOUS SUPERPHOSPHATES AND GUANOS, SAMPLED BY THE STATION.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.
10483	Formula A.	L. Sanderson, New Haven.	F. O. Ives, W. Cheshire. R. M. Goodale, Durham. A. B. Morse & Son, Guilf'd.	35.00 } 35.00 } 33.00 }
10583	Fish and Potash, Square Brand.	Bowker Fertilizer Co., Boston.	E. F. Miller, Ellington.	27.00 }
10392	Circle Brand Ground Bone with Potash.	Bradley Fertilizer Co., Boston.	C. O. Jelliff, Southport.	28.00 }
10660	Great Planet A.	Clark's Cove Fertilizer Co., New York.	Wells & Dean, Bloomfield.	37.00 }
10354	Fish and Potash.	National Fertilizer Co., Bridgeport.	G. A. & H. B. Williams, East Hartford. Manufacturer.	30.00 }
10473	Standard Pure Bone Superphosphate.	Lister's Agricult'l Chemical Works, Newark, N. J.	A. N. Clark, Milford. A. W. Hutchinson, Gilead.	28.00 } 28.00 }
10700	Garden Special Fertilizer.	Great Eastern Fertilizer Co., Rutland, Vt.	Silas Finch, Greenwich.	34.00 }
10655	Superior Truck Fertilizer.	M. E. Wheeler & Co., Rutland, Vt.	I. J. Scoville, Plainville.	36.00 }
10559	Fish and Potash.*	Rogers Manufacturing Co., Rockfall, Conn.	Manufacturer. W. T. Andross, E. Hartf'd.	28.00 } 30.00 }
10425	Complete Fertilizer.	National Fertilizer Co., Bridgeport.	G. A. & H. B. Williams, East Hartford. J. F. Buckhout, Greenw'ch. A. G. Beach, Seymour. Manufacturer.	38.00 } 38.00 } 37.00 } 35.00 }
10683	Vegetable Bone Superphosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	The Meeker Coal Co., Norwalk.	41.00 }
10729	New Method Fertilizer.*	Bradley Fertilizer Co., Boston.	H. S. Harvey, Windham Center. Sanford & Hawley, Unionville. Wilson & Burr, Middlet'n.	28.00 } 26.00 } 30.00 }
10493	Success Fertilizer.	Lister's Agricult'l Chemical Works, Newark, N. J.	M. D. Stanley, N. Britain. A. W. Hutchinson, Gilead.	25.00 } 26.00 }
10751	Special Manure, 10 per cent. Potash.	L. Sanderson, New Haven.	A. B. Morse & Son, Guilford.	33.00 } 35.00 }
10578	Ammoniated Bone Phosphate.	Berkshire Mills Co., Bridgeport.	Johnson Bros., Jewett City. T. H. Eldridge, Norwich. Manufacturer.	28.00 } 28.00 } 28.00 }
10565	Complete Bone Superphosphate.	Wilcox Fertilizer Works, Mystic.	W. A. Howard, Woodst'k. Manufacturer. F. A. Rathbun, Hebron.	29.00 } 30.00 } 32.00 }
10682	A. A. Complete Manure.	Crocker Fertilizer Co., Buffalo, N. Y.	C. F. Tallard & Son, Broad Brook.	35.00 }
10356	Chittenden's Market Garden.	National Fertilizer Co., Bridgeport.	Manufacturer.	32.00 }
10419	Farmers' New Method.*	Bradley Fertilizer Co., Boston.	D. L. Clark, Milford. W. H. Scott, Pequabuck.	28.00 } 29.00 }
10488	Dissolved Bone and Potash.	Milsom Rend. and Fertilizer Co., East Buffalo, N. Y.	D. E. Doolittle, West Cheshire. Chas. H. Davis, Guilford.	28.50 } 17.50 }

ANALYSES.—*Continued.*

Valuation per ton.	Percentage difference between cost and valuation.	NITROGEN.					PHOSPHORIC ACID.						POTASH.			
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Total Nitrogen.		Reverted.	Insoluble.	Total.		Available.		Found.			
					Found.	Guaranteed.			Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.	
\$23.28	50.3	0.46	0.66	1.98	3.10	3.05	1.17	4.77	2.12	12.06	10.0	9.94	8.0	6.32	6.32	6.0
17.93	50.6	...	0.33	2.59	2.92	2.3	3.23	3.47	1.60	8.30	8.0	6.70	...	4.04	4.04	4.0
18.39	52.3	.....	.....	2.62	2.62	1.9	1.94	6.78	4.32	13.04	10.0	8.72	6.0	2.53	2.53	2.0
24.26	52.5	0.77	0.52	2.31	3.60	3.3	3.62	5.37	2.40	11.39	9.0	8.99	8.0	6.84	6.84	7.0
19.66	52.6	.....	.....	3.07	3.07	3.0	3.86	2.52	2.82	9.20	6.0	6.38	...	0.45	4.51	4.0
18.13	54.4	.....	.....	2.32	2.32	2.4	8.93	1.86	1.30	12.09	12.0	10.79	10.0	1.86	1.86	1.5
22.02	54.4	.....	.....	3.22	3.22	3.3	4.96	2.15	0.90	8.01	....	7.11	6.0	7.60	7.60	8.0
23.24	54.9	...	0.17	3.15	3.32	3.5	5.90	1.55	0.89	8.34	....	7.45	7.0	8.27	8.27	8.0
18.00	55.6	...	0.23	2.58	2.81	3.3	1.28	3.89	4.58	9.75	6.0	5.17	....	4.77	4.77	3.8
23.73	55.9	.....	1.52	2.05	3.57	3.3	4.29	5.42	0.92	10.63	10.0	9.71	8.0	6.07	6.07	6.0
26.05	57.4	.....	2.22	2.90	5.12	5.05	5.41	2.01	0.31	7.73	....	7.42	6.0	6.01	6.01	6.0
17.75	57.7	.....	.....	2.21	2.21	1.7	5.66	3.86	1.92	11.44	10.0	9.52	8.0	3.07	3.07	3.0
15.83	57.9	.....	.....	1.58	1.58	1.7	7.81	2.53	1.06	11.40	11.5	10.34	9.5	1.80	2.21	2.0
22.06	58.6	0.69	0.10	1.71	2.50	2.5	2.86	3.97	2.65	9.48	8.0	6.83	6.0	9.87	9.87	10.0
17.58	59.3	.....	.....	2.07	2.07	1.7	4.53	4.80	3.35	12.68	10.0	9.33	8.0	0.47	2.59	2.0
18.75	60.0	.....	.....	2.72	2.72	2.0	2.37	5.31	3.90	11.58	9.0	7.68	8.0	3.75	3.75	3.0
21.84	60.3	...	0.27	3.10	3.37	3.3	4.97	2.24	1.04	8.25	....	7.21	8.0	6.73	6.73	7.5
19.95	60.4	...	1.13	1.35	2.48	2.5	3.89	4.56	1.57	10.02	9.0	8.45	7.0	6.15	6.15	6.0
17.71	60.9	.....	.....	2.16	2.16	1.7	5.94	3.86	2.15	11.95	10.0	9.80	8.0	2.77	2.77	3.0
10.81	61.9	.....	.....	.....	.....	7.14	.....	3.56	0.20	10.90	11.0	10.70	9.0	1.71	1.71	1.7

NITROGENOUS SUPERPHOSPHATES AND GUANOS, SAMPLED BY THE STATION.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.
10448	High Grade Ammoniated Bone Superphosphate.	E. Frank Coe Co., New York.	E. Brewer & Son, Hockanum. J. R. Babcock, Mystic. J. P. Barstow, Norwich.	..... \$29.00 32 00 30 00
10638	Americus Ammoniated Bone Superphosphate.	Williams & Clark, New York.	D. B. Wilson, Waterbury. A. B. Garfield, E. Canaan.	30.00 33.00 31 50
10353	Complete Manure Brand.	A Mapes F. & P. G. Co., New York.	Birdsey & Foster, Meriden.	34.00
10678	Superphosphate.	Cumberland Bone Phosphate Co., Boston.	Mapes Branch, Hartford. Kahn Bros., Yantic.	33.00 28.00
10418	Cereal Brand.	Mapes F. & P. G. Co., New York.	A. N. Clark, Milford. Mapes Branch, Hartford. D. B. Wilson, Waterbury.	28.00 26.00 32.00 27.00
10534	Animal Fertilizer.	Lowell Fertilizer Co., Boston.	G. G. Avery, New London. W. D. Penfield, Cobalt. S. H. Bowen, Brooklyn. J. F. Sheridan & Bro., Manchester.	33.00 33.00 33.00 33.00
10772	Gold Brand Guano.*	E. Frank Coe Co., New York.	L. C. Grant, Talcottville.	35.00
10420	Special Phosphate.	Olds & Whipple, Hartford.	Manufacturer.	34.00
10593	Ammoniated Bone and Potash.	Wm. E. Brightman, Tiverton, R. I.	Wm. Crane, Broad Brook.	30.00
10347	Patent Superphosphate.	Bradley Fertilizer Co., Boston.	Wheeler & Howe, Bridgeport. D. L. Clark, Milford. E. E. Scoville, Stamford.	33.00 30.00 34.00 32.00
10521	A. A. Ammoniated Superphosphate.	H. J. Baker & Bro., New York.	Edward White, Rockville. W. F. Andross, E. Hartford. Saxton & Strong, Bristol.	32.00 35.00 34.00
10349	Hill and Drill Phosphate.	Bowker Fertilizer Co., Boston.	C. W. Michaels, Yalesville. Peck Bros., West Cheshire.	32.00 34.00
10524	King Philip Alkaline Guano.	Clark's Cove Fertilizer Co., New York.	J. M. Burk, So. Manchester. H. E. Daniels, N. London.	24.00 24.00
10337	High Grade Universal Fertilizer.	Packer's Union Fertilizer Co., New York.	C. O. Jelliff, Southport. J. H. Ray & Son, Greenwich.	25.00 28.00 26.50
10422	Quinnipiac Phosphate.	Quinnipiac Co., Boston.	Gault Bros., Westport. H. S. Coe, Harwinton. Olds & Whipple, Hartford	32.00 33.00 35.00 33.00
10668	Crossed Fishes Brand Fish and Potash.	Quinnipiac Fertilizer Co., Boston.	Olds & Whipple, Hartford.	32.00
10686	Superphosphate.	Cleveland Dryer Co., Boston.	C. E. Main, Plainfield.	30.00
10618	Fish, Bone, and Potash.	Read Fertilizer Co., New York.	J. M. White, Bristol. E. E. Pitney, Ellington.	30.00 28.00 29.00
10533	Soluble Pacific Guano.	Pacific Guano Co., Boston.	J. A. Nichols, Danielson. John Bransfield, Portland. Saxton & Strong, Bristol.	30.00 30.00 33.00 31.00

ANALYSES.—*Continued.*

Valuation per ton.	Percentage difference between cost and valuation.	NITROGEN.					PHOSPHORIC ACID.					POTASH.				
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Total Nitrogen.			Reverted.	Insoluble.	Total.		Available.		Found.		
					Found.	Guaranteed.	Soluble.			Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
\$18.51	62.1	...	0.46	2.00	2.46	2.07	3.31	2.09	2.00	11.40	11.0	9.40	9.0	0.39	2.63	1.9
19.38	62.5	0.28	0.20	2.40	2.88	2.56	6.48	3.58	2.40	12.46	10.0	10.06	9.0	2.02	2.02	2.0
20.20	63.4	0.30	0.26	2.40	2.96	2.53	3.54	6.06	3.23	12.83	12.0	9.60	10.0	3.11	3.11	2.5
17.12	63.5	0.20	...	2.08	2.28	2.15	5.57	3.98	2.05	11.60	10.0	9.55	8.0	2.08	2.08	2.0
16.41	64.5	...	...	2.12	2.12	1.74	4.93	3.52	0.77	9.22	8.0	8.45	6.0	3.41	3.41	3.0
20.06	64.5	...	0.16	2.46	2.62	2.56	6.00	4.24	0.89	11.13	10.0	10.24	9.0	4.20	4.20	4.0
21.24	64.8	...	0.88	1.80	2.68	2.06	6.69	2.13	2.68	11.50	9.0	8.82	8.0	0.45	5.02	6.0
20.61	65.0	...	0.63	2.37	3.00	2.56	6.88	3.53	2.14	12.55	10.0	10.41	9.0	0.67	2.44	2.0
18.05	66.2	0.23	...	2.03	2.26	2.16	6.06	3.63	2.02	11.71	9.0	9.69	8.0	3.07	3.07	3.0
19.24	66.3	0.12	0.10	2.48	2.70	2.57	7.02	3.84	1.42	12.28	11.0	10.86	9.0	2.06	2.06	2.0
20.38	66.8	0.58	0.92	1.38	2.88	2.58	8.98	1.74	1.11	11.83	11.0	10.72	10.0	2.96	2.96	2.0
19.14	67.2	0.12	...	2.66	2.78	2.38	8.06	2.18	1.25	11.49	12.0	10.24	9.0	2.22	2.22	2.0
14.29	67.9	...	...	1.32	1.32	1.06	6.40	2.58	2.01	10.99	9.0	8.98	8.0	2.32	2.32	2.0
15.73	68.5	...	...	1.12	1.12	0.86	6.64	2.15	0.80	9.59	...	8.79	8.0	5.37	5.37	5.0
19.41	70.0	0.30	0.36	2.18	2.84	2.56	6.08	4.10	2.13	12.31	10.0	10.18	9.0	2.26	2.26	3.5
18.81	70.1	...	0.26	3.24	3.50	3.31	5.55	3.20	4.10	8.85	5.0	4.75	3.0	4.01	4.01	3.0
17.57	70.7	trace	...	2.35	2.35	2.06	6.00	3.78	1.54	11.32	...	9.78	9.0	2.29	2.29	2.0
16.91	71.5	...	...	2.88	2.88	2.53	3.01	2.42	0.97	6.40	5.0	5.43	4.0	4.48	4.48	4.0
18.04	71.8	0.09	0.16	2.24	2.49	2.35	5.81	3.94	2.07	11.82	10.5	9.75	...	2.21	2.21	2.0

NITROGENOUS SUPERPHOSPHATES AND GUANOS, SAMPLED BY THE STATION.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.
10424	Ammoniated Bone Phosphate.	National Fertilizer Co., Bridgeport.	G. A. & H. B. Williams, East Hartford.	\$30.00
			Ansonia Flour and Grain Co., Ansonia.	32.00
			Manufacturer.	28.00
				30.00
10401	Square Brand Bone and Potash.	Bowker Fertilizer Co., Boston.	C. T. Leonard, Norwalk.	25.00
			E. W. S. Pickett, Fairfield	28.00
			Bowker's Branch, Hartfd.	27.00
				26.50
10528	Guano for All Crops.	Standard Fertilizer Co., Boston.	F. J. Newton, Branford.	26.00
			W. E. Truesdell, Burnside.	24.00
				25.00
10599	Original Coe's Superphosphate.	Bradley Fertilizer Co., Boston.	Wilson & Burr, Middletown.	30.00
10627	Dissoived Bone and Potash.	Lowell Fertilizer Co., Boston.	F. A. Chamberlain, Unionville.	.....
			N. N. King, Thomps'nv'l	28.00
			J. W. Beard, Plainville.	30.00
			G. M. Bradley, Danbury.	31.00
				29.00
10691	Buffalo Fertilizer.	Milsom Rend. and Fertilizer Co., East Buffalo, N. Y.	I. J. Scoville, Plainville.	26.50
10654	Original Bay State.	H. F. Tucker Co., Boston	W. R. Amadon, Staffordville.	30.00
10640	Defiance Phosphate.	Clark's Cove Fertilizer Co., New York.	H. E. Daniels, New London.	22 00
10596	Eclipse Phosphate.	Bradley Fertilizer Co., Boston.	C. F. Tallard & Son, Broad Brook.	29.00
			W. W. Sheldon, So. Woodstock	27.00
				28.00
10526	Imperial Bone Superphosphate for All Crops.	H. F. Tucker Co., Boston.	F. H. Rolf, Guilford.	28 00
			E. A. Buck & Co., Williamantic.	28.00
10692	Buffalo Guano.	Milsom Rend. and Fertilizer Co., East Buffalo, N. Y.	Chas. H. Davis, Guilford.	25.00
10523	B. D. Sea Fowl Guano.	Bradley Fertilizer Co., Boston.	F. S. Bidwell, Windsor Locks.	30.00
			W. W. Cooper, Suffield.	30.00
10492	New Rival Ammoniated Superphosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	Clark & Bradley, North Westchester.	24.00
			W. Gildersleeve, Gildersleeve.	35.00
				28.00
10467	Sure Crop Phosphate.	Bowker Fertilizer Co., Boston.	Hubbell & Bradley, Saugatuck.	28.00
			C. T. Leonard, Norwalk.	24.00
			H. E. Daniels, N. London.	26.00
			Wm. Crane, Broad Brook	28.00
10591	Brightman's Fish and Potash.	Wm. E. Brightman, Tiverton, R. I.		
10350	Bowker's Ammoniated Dissolved Bone, or Farm and Garden Phosphate.	Bowker Fertilizer Co., Boston.	E. B. Clark Co., Milford.	26.00
			C. T. Leonard, Norwalk.	38.00
			Linsley & Lightbourn, New Haven.	35.00
				30.00

ANALYSES—*Continued.*

Valuation per ton.	Percentage difference between cost and valuation.	NITROGEN.					PHOSPHORIC ACID.					POTASH.			
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.	
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.
\$17.44	72.0	.....	.....	2.22	2.22	1.6	2.08	8.28	1.45	11.81	9.0	10.36	7.0	2.53	2.53 2.0
15.37	72.4	.....	.....	1.95	1.95	1.5	2.82	4.72	4.23	11.77	12.0	7.54	6.0	2.24	2.24 2.0
14.49	72.5	.....	.....	1.40	1.40	1.0	7.12	2.15	1.49	10.76	10.0	9.27	8.0	2.16	2.16 2.0
17.37	72.7	.....	.....	2.32	2.32	2.1	5.98	4.21	1.87	12.06	10.0	10.19	8.0	1.61	1.61 1.0
16.75	73.1	.....	.....	2.05	2.05	1.7	7.39	2.45	1.35	11.19	10.0	9.84	9.0	2.19	2.19 1.0
15.28	73.4	.....	.....	2.10	2.10	1.9	5.89	2.02	2.66	10.57	9.0	7.91	8.0	1.67	1.67 1.5
17.25	73.9	0.20	.....	2.02	2.22	2.1	6.10	3.74	1.98	11.82	11.0	9.84	9.0	2.12	2.12 2.0
12.54	75.4	.....	.....	1.04	1.04	0.8	6.27	3.01	1.45	10.73	9.0	9.28	7.0	1.17	1.17 1.0
15.82	77.0	0.14	.....	1.58	1.72	1.0	6.58	3.70	1.80	12.08	12.0	10.28	10.0	1.69	1.69 1.5
15.76	77.7	.....	.....	1.86	1.86	1.3	5.55	3.61	1.84	11.00	11.0	9.16	9.0	2.26	2.26 1.9
13.98	78.8	.....	.....	0.85	0.85	0.8	6.26	2.54	0.78	9.58	9.0	8.80	8.0	4.27	4.27 4.0
16.42	82.7	.....	.....	2.09	2.09	2.0	6.59	3.22	2.10	11.91	10.0	9.81	8.0	1.43	1.43 1.5
15.24	83.7	.....	.....	1.52	1.52	1.2	7.78	2.87	0.72	11.37	.....	10.65	10.0	1.64	1.64 1.6
14.15	83.7	0.14	.....	1.02	1.16	0.8	7.47	3.24	1.92	12.63	10.0	10.71	8.0	1.00	1.00 1.0
15.15	84.8	.....	0.23	2.32	2.55	2.1	2.34	3.68	2.35	8.37	7.5	6.02	6.0	2.38	2.38 2.0
16.17	85.5	0.14	.....	1.78	1.92	1.5	6.50	2.77	2.29	11.56	10.0	9.27	8.0	2.17	2.17 2.0

NITROGENOUS SUPERPHOSPHATES AND GUANOS, SAMPLED BY THE STATION.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.
10696	Cereal Brand.	Frederick Ludlam, New York.	J. M. Beckwith, Chesterfield.	\$26.00
10687	Fertilizer for All Crops.	Cleveland Dryer Co., Boston.	C. E. Main, Plainfield.	27.00
10671	Triumph.	Niagara Fertilizer Co., Buffalo, N. Y.	C. A. Ahlquist, Portland.	35.00
10652	Standard Fertilizer.	Standard Fertilizer Co., Boston.	W. E. Truesdell & Co., Burnside.	32.00
10471	General Crop Phosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	Clark & Bradley, North Westchester.	20.00
			Henry Davis, Durham Center.	20.00
			The Meeker Coal Co., Norwalk.	25.00
10637	Royal Bone Phosphate.	Williams & Clark, New York.	D. S. Buell, Madison.	27.00
			S. E. Brown, Collinsville.	28.00
10662	Leader Guano.	Read Fertilizer Co., New York.	J. R. Babcock, Mystic.	27.50
10530	Climax Phosphate.	Quinnipiac Co., Boston.	Bailey & Markham, Cobalt.	35.00
			C. A. Young, Danielson.	28.00
			W. C. Pease, Somers.	29.00
			O. S. Olmsted, Melrose.	26.00
10619	Standard Superphosphate.	Read Fertilizer Co., New York.	J. W. Palmer, Stamford.	32.00
			J. R. Babcock, Mystic.	27.00
			J. N. Clark, Columbia.	28.00
10598	Niagara Phosphate.	Bradley Fertilizer Co., Boston.	Sanford & Hawley, Unionville.	25.00
			Wilson & Burr, Middletown.	25.00
			P. Schwartz, Chesterfield.	25.00
			H. S. Harvey, Windham Center.	21.00
10669	Nobsque Guano.	Pacific Guano Co., Boston.	James A. Nichols, Danielson.	28.00
10609	General Fertilizer.	Great Eastern Fertilizer Co., Rutland, Vt.	Silas Finch, Greenwich.	29.00
			Elmer Keeler, Danbury.	30.00
10688	Pioneer.	Cleveland Dryer Co., Boston.	C. E. Main, Plainfield.	29.50
10680	Hawkeye Fertilizer.	Cumberland Bone Phosphate Co., Boston.	Geo. C. Dean, Plainfield.	27.00
10693	Erie King.	Milsom Rend and Fertilizer Co., East Buffalo, N. Y.	D. E. Doolittle, West Cheshire.	24.00
10685	Gold Brand Excelsior Guano.*	E. Frank Coe Co., New York.	Edgar Brewer & Son, Hockanum.	.....
10445	Fertilizer.	Connecticut Reduction Co., Bridgeport.	Manufacturer.	18.00
			W. H. Tinkham, Milford.	16.00
			D. B. Wilson, Waterbury.	15.00
10315	Fertilizer.	L. Sanderson, New Haven.	F. S. Hopson, Stratford.	.....

* See page 49.

ANALYSES—Continued.

Valuation per ton.	Percentage difference between cost and valuation.	NITROGEN.						PHOSPHORIC ACID.						POTASH.			
		N Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Total Nitrogen.			Reverted.	Insoluble.	Total.		Available.		As Muriate.	Found.	Guaranteed.	
					Found.	Guaranteed.	Soluble.			Found.	Guaranteed.	Found.	Guaranteed.				
\$13.98	86.0	0.20	....	0.98	1.18	0.8	7.25	3.31	1.93	12.49	10.0	10.56	....	0.91	0.91	1.0
14.35	88.2	....	....	1.29	1.29	1.0	7.30	1.99	1.37	10.66	9.0	9.29	8.0	2.39	2.39	2.0
18.57	88.5	....	....	2.88	2.88	2.5	6.40	2.20	2.77	11.37	...	8.60	8.0	2.21	2.21	2.2
16.89	89.5	0.26	....	1.92	2.18	2.0	5.79	3.70	2.11	11.60	10.0	9.49	8.0	2.14	2.14	2.0
11.43	92.5	....	....	1.26	1.26	0.8	4.09	3.65	1.20	8.94	....	7.74	7.0	0.96	0.96	1.0
14.21	93.5	....	....	1.32	1.32	1.0	5.39	3.57	1.95	10.91	8.0	8.96	7.0	2.37	2.37	2.0
12.65	93.7	....	....	1.34	1.34	0.8	5.11	2.58	0.82	8.51	8.0	7.69	7.0	2.25	2.25	2.0
14.29	95.9	....	....	1.27	1.27	1.0	7.05	2.20	1.62	10.87	9.0	9.25	8.0	2.32	2.32	2.0
14.57	99.0	....	....	1.15	1.15	0.8	6.29	2.32	0.92	9.53	9.0	8.61	8.0	4.07	4.07	4.0
12.32	102.9	....	....	1.25	1.25	0.8	4.19	3.75	2.19	10.13	8.0	7.94	7.0	1.38	1.38	1.0
13.57	106.3	....	....	1.18	1.18	1.2	6.69	2.11	1.33	10.13	9.0	8.80	8.0	2.39	2.39	2.0
14.29	106.4	....	....	1.10	1.10	0.8	6.42	1.92	0.79	9.13	....	8.34	8.0	4.20	4.20	4.0
11.42	110.2	....	....	0.98	0.98	0.8	3.15	5.01	2.14	10.30	9.0	8.16	7.0	1.14	1.14	1.0
12.39	117.9	....	....	1.17	1.17	0.8	4.67	3.62	2.52	10.81	9.0	8.29	7.0	1.18	1.18	1.0
10.70	124.3	....	....	0.90	0.90	0.8	5.22	2.19	0.69	8.10	9.0	7.41	7.0	1.71	1.71	2.0
21.03	0.85	1.81	2.66	2.0	6.80	2.22	2.48	11.50	9.0	9.02	8.0	0.27	4.73	6.0
....	....	....	....	2.70	2.70	3.5	none	2.73	1.44	4.17	...	2.73	3.5	0.40	0.40	3.1
27.57	....	0.77	....	3.09	3.86	4.0	5.30	4.39	1.41	11.10	....	9.69	9.0	9.50	9.50	8.0

2 and 3. Sampled by Manufacturers and Purchasers.

In the table below is given one analysis of a nitrogenous superphosphate, sampled by a manufacturer, and nine analyses of samples sent to the Station by purchasers.

10462. Fish, Bone, and Potash. Mr. E. R. Kelsey wrote that the sample represents goods made early in the year. The manufacturer afterwards had his stock of potash salts analyzed at the Station, and, finding the percentage of potash lower than represented in the German analysis, on which he had based his formula, worked over his stock, adding more potash to it.

10245 and 10217. Made by the Connecticut Reduction Co. or Bridgeport Utilization Co., represent garbage fertilizers to which reference has been already made, page 49.

The solubility of the nitrogen in pepsin solution, a reagent which, in a general way, measures the availability of the nitrogen, was found to be very low, 17.0 and 18.1 per cent., respectively.

It is, therefore, probable that the nitrogen of the material is of very inferior value as plant food. Consequently, no valua-

NITROGENOUS SUPERPHOSPHATES, SAMPLED BY MANUFACTURERS (

Station No.	Name of Brand.	Manufacturer.	Sampled by	Valuation per ton.
10713	Bone, Blood, and Potash.	Armour Fertilizer Co., Chicago.	Manufacturer.	\$28.95
10289	Bowker's Fairfield Formula.	Bowker Fertilizer Co., Boston.	Simeon Pease, Greenfield Hill.	27.92
10538	Red Brand Excelsior Guano.	E. Frank Coe Co., New York.	Sidney B. Smith, East Haven.	24.75
10462	Fish, Bone, and Potash.	E. R. Kelsey, Short Beach.	E. C. Warner, Fair Haven.	18.95
10369	Conn. Valley Orchard Co.'s Fertilizer.	Quinnipiac Co., Boston.	Earl Cooley, Berlin.	23.85
10363	Scientific Economy Fertilizer.	The Scientific Fertilizer Co., Pittsburgh, Pa.	R. K. Woodward, Amenia Union, N. Y.	17.51
10245	Fertilizer.	Connecticut Reduction Co., Bridgeport.	S. E. Frisbie, Milford.	.....
10217	Fertilizer.	Bridgeport Utilization Co., Bridgeport.	Joseph Lee, Southport.	....
10366	Berkshire Complete Fertilizer.	Berkshire Mills Co., Bridgeport.	M. A. Fitzgerald, Stratford.	....
10365	Berkshire Complete Fertilizer.	Berkshire Mills Co., Bridgeport.	M. A. Fitzgerald, Stratford.	....

tion is assigned to these goods, and the facts regarding them were published promptly in Bulletin 127.

Nitrogen solubility was also determined in 10289, Fairfield formula, made by the Bowker Fertilizer Co., and was found satisfactory, 74.2 per cent.

The last two samples, 10360 and 10366, were sent to ascertain whether the percentage of nitrogen was in both cases as guaranteed.

SPECIAL MANURES.

Here are included such mixed fertilizers, chiefly nitrogenous superphosphates, as are claimed by their manufacturers to be specially adapted to the needs of particular crops.

1. *Samples drawn by Station Agents.*

In the tables on pages 66 to 79 are given analyses of one hundred and eleven samples drawn by the Station agents and representing one hundred and seven brands.

AND PURCHASERS. ANALYSES AND VALUATIONS.

NITROGEN.					PHOSPHORIC ACID.					POTASH.			
Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.	
			Found.	Guaran- teed.				Found.	Guaran- teed.	Found.	Guaran- teed.	As Muriate.	Total.	Guaranteed.
0.77	3.91	4.68	4.1	7.04	2.50	1.40	10.94	10.0	9.54	8.0	0.26	7.17	7.0
0.90 0.10 3.10	4.10	4.0	5.65	2.79	.80	9.24	.....	8.44	8.0	10.56	10.56	8.0
. . . . 1.00 2.59	3.59	3.5	7.01	1.35	1.43	9.79	10.0	8.36	9.0	.61	6.86	6.0	
. . . . 0.88 2.81	3.69	3.3	2.54	2.99	.69	6.22	.....	5.53	4.0	.49	3.76	.....
1.56	2.63	4.19	4.1	6.70	2.97	2.32	11.99	9.67	9.0	3.64	3.64	3.0
.	2.44	2.44	2.1	4.18	4.06	1.20	9.44	9.0	8.24	7.5	3.49	4.0
.	2.65	2.65	2.6	None.	2.53	1.23	3.76	2.53	4.5	0.37	0.37	3.1
.	3.35	2.6	None.	2.00	1.65	3.65	.....	2.00	4.5	.....	0.34	3.1
.	3.10	2.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
.	3.44	3.3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

GUARANTEES.

Of the one hundred and eleven samples analyzed, thirty-three do not fulfill the manufacturer's minimum guarantee in respect of one ingredient, and six are each deficient in respect of two ingredients. The causes of these deficiencies have in part been mentioned on page 47.

Thirteen were deficient in nitrogen, twenty-two in potash, and ten in phosphoric acid. In eight of the ten cases, however, the available phosphoric acid was as guaranteed, the deficiency being only in the insoluble part of the phosphoric acid.

COST AND VALUATION.

The average cost per ton of the one hundred and eleven samples examined was \$33.11, the valuation \$21.72, and the percentage difference 52.4.

In 1897 the corresponding figures were: Average cost, \$34.34; average valuation, \$24.28; percentage difference, 41.4.

Analyses requiring Special Notice.

No. **10585**, pp. 70 and 71. Stockbridge Top Dressing, made by the Bowker Fertilizer Co., Boston, Mass. The manufacturer called attention to the fact that the nitrogen found, 3.93 per cent., was nearly one per cent. under the guarantee, and, in view of the discrepancy, asked that another sample be drawn. This was done, and the analysis, No. **10728**, pp. 70 and 71, made on another sample shows 5.67 per cent. of nitrogen, but only 4.36 per cent. of potash, being less than the guarantee, 6.0 per cent., and less than was found in the first sample, 6.47 per cent. The reason for these variations does not appear.

10664, pp. 76 and 77. Vegetable and Vine Manure. Made by the Read Fertilizer Co., N. Y. city. The manufacturer stated that as the percentage of potash, 6.90, was considerably under the guarantee, 8.0 per cent., he believed that the sample did not fairly represent the goods, and asked that another sample be drawn and analyzed. This was done, and the results are given in No. **10752**, pages 74 and 75. The percentage of potash found in this sample was much nearer, though not up to the maker's guarantee.

A similar request was made regarding No. **10694**, pp. 78 and 79. Wheat, Oats, and Barley Phosphate. Made by the Milsom Rendering and Fertilizer Co., East Buffalo, N. Y. Another analysis, **10773**, made on a different sample, gave essentially the same percentage of potash as the first analysis.

10417, pp. 78 and 79. Wheat and Corn Producer. Made by the Niagara Fertilizer Works, Buffalo, N. Y. The manufacturer stated that this analysis did not fairly represent the general quality of this brand, which contained more potash than was found in our analysis.

A second analysis, made on another sample, **10730**, showed composition very similar to the first.

10402. Wilson's Corn and Grain Fertilizer, pp. 68 and 69. Made for D. B. Wilson & Co., Waterbury, by the Bowker Fertilizer Co., Boston. But a small quantity of this fertilizer was shipped into the state and was subsequently withdrawn.

SPECIAL MANURES SAMPLED BY THE STATION.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.
10710	Seeding Down Manure.	Mapes F. & P. G. Co., N. Y.	Manufacturer.	\$35.00
10405	High Grade Grass and Grain Fertilizer.	Rogers Mfg. Co., Rockfall.	Manufacturer.	37.00
10736	High Grade Grass and Grain.	Rogers Mfg. Co., Rockfall.	Manufacturer.	37.00
10403	Hubbard's Grass and Grain Fertilizer.	Rogers & Hubbard Co., Middletown.	H. W. Andrews, Wallingford.	38.00
			City Coal & Wood Co., New Britain.	37.00
10701	Tobacco Grower.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	J. B. Pease, Melrose.	37.50
10647	Oats and Top Dressing.	Rogers Mfg. Co., Rockfall.	Manufacturer	42.00
10656	Americus Fine Wrapper Tobacco Grower.	Williams & Clark, New York.	J. Barnard, Simsbury.	40.00
10331	Hubbard's Soluble Tobacco Manure.	Rogers & Hubbard Co., Middletown.	H. W. Andrews, Wallingford.	42.00
			C. L. Luce, New Britain.	40.00
10332	Armour's Grain Grower.	Armour Fertilizer Works, Chicago.	C. J. Benham, New Haven.	25.00
			Adams & Canfield, Winthrop.	21.00
10400	Hubbard's Oats and Top Dressing.	Rogers & Hubbard Co., Middletown.	City Coal & Wood Co., New Britain.	48.00
			H. W. Andrews, Wallingford.	49.00
10649	Special Tobacco Manure.	Russia Cement Co., Gloucester, Mass.	W. C. Bulkley, Forestville.	47.00
10525	Tobacco Ash Elements.	Bowker Fertilizer Co., Boston.	J. B. Parker, Poquonock.	43.00
			H. K. Brainard, Thompsonville	32.00
			G. M. Risley, Windsor.	30.00
10586	Tobacco Ash Fertilizer.	Bowker Fertilizer Co., Boston.	Bowker's Branch, Hartford.	32.00
			G. M. Risley, Windsor.	40.00
			Bowker's Branch, Hartford.	42.00
10241	Preston's Potato Phosphate.	Preston Fertilizer Co., Greenpoint, L. I.	O. G. Beard,* Shelton.	41.00
10486	Essex Complete Manure for Corn, Grain, and Grass.	Russia Cement Co., Gloucester, Mass.	T. Anderson & Co., Cromwell.	31.00
			C. N. Jones, Wallingford.	38.00
			E. N. Pierce & Co., Plainville.	38.00
10485	Complete Manure for Potatoes, Roots, and Vegetables.	Russia Cement Co., Gloucester, Mass.	R. M. Burnham, East Windsor Hill.	39.00
			L. A. Carrier, Berlin.	40.00
			C. N. Jones, Wallingford.	38.00
10631	Hubbard's Potato Phosphate.	Rogers & Hubbard Co., Middletown.	H. W. Andrews, Wallingford.	30.00
			J. P. Barstow, Norwich.	30.00
10625	Tobacco Manure, Wrapper Brand.	Mapes F. & P. G. Co. New York.	Manufacturer.	30.00
			Mapes Branch, Hartford.	44.00
			D. W. Barnes, Windsor.	46.00

*Consumer, not a dealer.

ANALYSES AND VALUATIONS.

Valuation per ton.	Percentage difference between cost and valuation.	NITROGEN.					PHOSPHORIC ACID.					POTASH.				
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.		
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
\$30.48	14.8	1.69	...	1.09	2.78	2.5	...	...	...	17.65	18.0	...	...	11.09	11.09	10.0
31.56	17.2	0.36	0.13	2.38	2.87	3.0	...	...	...	15.22	16.0	...	...	14.64	14.64	12.5
31.14	18.8	0.06	0.10	2.56	2.72	3.0	...	...	...	17.45	16.0	...	...	13.14	13.14	12.5
30.91	21.3	...	...	3.04	3.04	2.5	...	...	...	18.37	16.5	...	...	11.96	11.96	12.5
31.14	22.0	...	2.23	2.79	5.02	4.9	3.82	3.74	1.08	8.64	8.0	7.56	7.0	0.33	10.28	10.0
33.31	26.1	4.76	0.14	1.72	6.62	6.3	1.87	6.08	0.66	8.61	9.0	7.95	...	10.49	10.49	7.5
31.58	26.7	0.86	1.83	2.89	5.58	5.8	4.35	1.52	1.68	7.55	6.0	5.87	5.0	0.76	10.43	10.0
31.52	26.9	1.31	...	3.54	4.85	5.0	1.76	7.65	1.20	10.61	10.0	9.41	7.0	0.99	10.17	10.0
17.97	27.9	...	...	2.36	2.36	1.6	4.34	5.16	3.18	12.68	10.0	9.50	8.0	1.33	2.25	2.0
37.52	27.9	7.73	...	1.55	9.28	8.8	...	...	...	8.47	7.9	...	...	8.48	8.48	8.4
33.29	29.2	...	1.37	3.68	5.05	4.5	4.70	3.12	1.12	8.94	8.0	7.82	...	0.67	12.07	12.0
24.73	29.4	...	...	...	...	...	0.08	8.43	3.71	12.22	...	8.51	6.0	1.26	16.63	15.0
31.61	29.7	2.96	...	0.55	3.51	3.0	...	8.67	4.20	12.87	...	8.67	5.0	1.36	13.95	13.0
23.73	30.6	0.34	...	1.81	2.15	1.6	4.50	4.65	1.99	11.14	...	9.15	7.0	9.62	10.66	10.0
29.05	30.8	0.91	...	3.38	4.29	3.7	4.69	4.86	1.85	11.40	9.5	9.55	...	9.85	9.85	9.5
29.77	31.00	0.24	0.72	3.34	4.30	3.7	4.94	4.54	1.69	11.17	9.0	9.48	...	0.80	9.14	8.5
22.75	31.9	0.68	...	1.96	2.64	2.0	7.70	3.90	2.08	13.68	10.0	11.60	9.0	5.42	5.42	5.0
33.36	31.9	3.07	1.67	1.72	6.46	6.2	0.26	5.06	0.42	5.74	4.5	5.32	...	0.81	11.55	10.5

SPECIAL MANURES SAMPLED BY THE STATION.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.
10567	Potato, Onion, and Tobacco Manure.	Wilcox Fertilizer Works, Mystic.	W. A. Howard, Woodstock.	\$34.00
			F. A. Rathbun, Hebron.	37.00
			J. W. Dennison, Mystic.	31.00
			Manufacturer.	35.00
			C. M. Smith, E. Hartford.	35.00
10624	Tobacco Ash Constituents.	Mapes F. & P. G. Co., New York.	Mapes Branch, Hartford.	30.00
			F. S. Bidwell, Windsor Locks.	31.00
			W. W. Cooper, Suffield.	30.00
10611	Potato and Root Crop Manure.	L. B. Darling Fertilizer Co., Pawtucket, R. I.	A. I. Kinney, Terryville.	34.00
			Hotchkiss & Templeton, Waterbury.	36.00
10560	Complete for Potatoes and Vegetables.	Rogers Mfg. Co., Rockfall.	Manufacturer.	35.00
10610	Potato Manure.	Lister's Agricultural Chemical Works, Newark, N. J.	A. J. Palmer, Branford.	30.00
			Strong & Tanner, Winsted.	35.00
			Daniels Bros., Middletown.	30.00
			A. N. Clark, Milford.	34.00
				33.00
10329	Hubbard's Soluble Potato Manure.	Rogers & Hubbard Co., Middletown.	H. W. Andrews, Wallingford.	38.00
			City Coal & Wood Co., New Britain.	37.00
			C. L. Luce, New Britain.	36.00
10632	High Grade Soluble Tobacco Manure.	Rogers Mfg. Co., Rockfall.	J. F. Close, Round Hill.	38.00
			Manufacturer.	42.00
			W. F. Andross, East Hartford.	40.00
10338	Swift's Lowell Potato Phosphate.	Lowell Fertilizer Co., Boston.	J. C. Lincoln, Berlin.	30.00
			C. W. Lines, New Britain.	32.00
				31.00
10580	Complete Potato Manure.	H. J. Baker & Bro., New York.	Edward White, Rockville.	38.00
			J. W. Ives, Danbury.	35.00
				36.50
10633	High Grade Soluble Potato and General Crops.	Rogers Mfg. Co., Rockfall.	Manufacturer.	38.00
			F. S. Bidwell, Windsor Locks.	39.00
10402	*Wilson's Corn and Grain Fertilizer.	Bowker Fertilizer Co., Boston, Mass.	D. B. Wilson, Waterbury.	25.00
10595	High Grade Tobacco Manure.	Bradley Fertilizer Co., Boston.	H. C. Aborn, Ellington.	44.00
			D. T. Dyer, Collinsville.	46.00
				45.00
10351	Grass and Grain Spring Top Dressing.	Mapes F. & P. G. Co., New York.	Birdsey & Foster, Meriden.	39.00
10469	Stockbridge Potato and Vegetable.	Bowker Fertilizer Co., Boston.	Mapes Branch, Hartford.	38.00
			E. B. Clark & Co., Milford.	36.00
10330	Economical Potato Manure.	Mapes F. & P. G. Co., New York.	Birdsey & Foster, Meriden.	34.00
			Southington Lumber & Feed Co., Southington.	33.00
				33.50
10634	Special Potato Fertilizer.	H. F. Tucker Co., Boston.	E. A. Buck, Willimantic.	31.00
			Alfred Sneider, Rockville.	27.00
				29.00
10335	Potato Manure.	Mapes F. & P. G. Co., New York.	Birdsey & Foster, Meriden.	38.00
			A. N. Clark, Milford.	38.00

ANALYSES AND VALUATIONS.—*Continued.*

Valuation per ton.	Percentage difference between cost and valuation.	NITROGEN.					PHOSPHORIC ACID.						POTASH.			
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.		Guaranteed.
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	
\$25.55	33.1	0.81	....	3.16	3.97	3.3	3.98	4.17	1.51	9.66	8.0	8.15	7.0	0.07	7.08	6.0
22.29	34.6	....	....	0.64	0.64	0.5	....	4.43	1.89	6.32	5.7	4.43	....	0.92	16.34	15.0
25.91	35.1	0.63	0.23	3.32	4.18	2.8	3.76	6.22	1.18	11.16	10.0	9.98	9.0	5.44	6.32	7.0
22.09	35.8	0.90	....	1.56	2.46	2.3	6.30	6.04	1.86	14.20	10.0	12.34	....	4.87	4.87	5.0
24.22	36.2	....	1.24	2.32	3.56	3.7	6.72	1.88	0.96	9.56	8.5	8.60	7.5	7.43	7.43	7.0
27.14	36.3	1.34	....	3.67	5.01	5.0	1.78	6.66	1.54	9.98	10.0	8.44	7.0	1.00	5.98	5.0
30.75	36.6	1.42	....	3.02	4.44	5.0	1.76	6.74	1.13	9.63	8.0	8.50	....	0.77	11.29	11.0
22.64	36.9	....	....	2.89	2.89	2.5	6.30	2.66	0.35	9.31	9.0	8.96	8.0	0.14	6.63	6.0
26.56	37.4	0.52	1.83	1.44	3.79	3.3	5.92	.96	0.74	7.62	6.8	6.88	5.7	9.98	11.16	10.0
27.34	39.0	0.88	....	2.63	3.51	3.5	2.19	7.11	2.09	11.39	9.0	9.30	....	0.89	9.32	8.8
16.71	40.9	0.18	....	1.66	1.84	1.5	6.50	2.79	1.94	11.23	9.0	9.29	8.0	3.21	3.21	3.0
31.80	41.5	....	4.05	1.82	5.87	5.8	2.93	3.03	1.51	7.47	6.0	5.96	5.0	1.36	9.90	10.0
26.73	42.2	1.23	1.47	2.62	5.32	4.9	2.48	3.84	0.70	7.02	6.0	6.32	5.0	7.64	7.64	7.0
25.24	42.6	1.50	....	2.13	3.63	3.2	3.38	3.42	1.98	8.78	7.0	6.80	5.0	10.36	10.36	10.0
23.48	42.7	1.16	0.28	2.14	3.58	3.3	2.37	4.48	0.99	7.84	6.0	6.85	4.0	2.09	7.89	8.0
20.22	43.4	0.28	....	2.48	2.76	2.5	3.54	3.55	1.98	9.07	10.0	7.09	8.0	6.74	6.74	6.0
26.32	44.4	0.90	2.78	0.32	4.00	3.7	3.73	4.93	1.29	9.95	8.0	8.66	8.0	0.80	7.60	6.0

SPECIAL MANURES SAMPLED BY THE STATION.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.
10491	N. E. Potato and Tobacco Grower.	Crocker Fertilizer Co., Buffalo, N. Y.	Clark & Bradley, North Westchester.	\$30.00
			Walter Gildersleeve, Gildersleeve.	40.00
			The Meeker Coal Co., Norwalk.	34.00
10698	Tobacco Manure.	Lowell Fertilizer Co., Boston.	J. D. Beasley, Ellington.	32.00 40.00
10592	Special Tobacco and Market Garden.	Wm. E. Brightman, Tiverton, R. I.	William Crane, Broad Brook.	35.00
10648	Complete Corn Manure.	Rogers Mfg. Co., Rockfall.	Manufacturer.	35.00
10623	Tobacco Starter.	Mapes F. & P. G. Co., New York.	Mapes Branch, Hartford.	33.00
10607	Fruit and Vine.	Lowell Fertilizer Co., Boston.	D. W. Barnes, Windsor.	35.00
			W. D. Penfield, Cobalt.	37.00
			N. N. King, Thompsonville.	35.00 36.00
10728	*Stockbridge Top Dressing.	Bowker Fertilizer Co., Boston.	C. W. Michaels & Co., Yalesville.	38.00
10348	Complete Manure for Potatoes and Vegetables.	Bradley Fertilizer Co., Boston.	D. L. Clark, Milford.	36.00
			Lockwood & Hotchkiss, Ansonia.	35.00
			Mapes Branch, Hartford.	35.50
10475	Fruit and Vine Manure.	Mapes F. & P. G. Co., New York.	J. H. Barker, Branford.	37.00
10352	Corn Manure.	Mapes F. & P. G. Co., New York.	J. P. Barstow, Norwich.	39.00
			A. N. Clark, Milford.	40.00
10639	Potato and Corn Guano.	Preston Fertilizer Co., Greenpoint, L. I.	Mapes Branch, Hartford.	36.00
			Bronson Bros. & Co., Winchester Center.	34.00
			T. B. Wickwire, Berlin.	30.00
10566	Potato Manure.	Wilcox Fertilizer Works, Mystic.	Manufacturer.	30.00
			F. A. Rathbun, Hebron.	32.00
			W. A. Howard, Woodstock.	29.00
10600	Stockbridge Tobacco Manure.	Bowker Fertilizer Co., Boston.	H. K. Brainard, Thompsonville.	48.00
10585	*Stockbridge Top Dressing.	Bowker Fertilizer Co., Boston.	W. O. Goodsell, Bristol.	37.00
10661	Potato and Onion Fertilizer.	Preston Fertilizer Co., Greenpoint, L. I.	T. B. Wickwire, Berlin.	34.00
10466	Potato Fertilizer.	Cumberland Bone Phosphate Co., Boston.	Kahn Bros., Yantic.	28.00
			A. J. Palmer, Branford.	27.00
				27.50
10666	Onion Manure.	Quinnipiac Fertilizer Co., Boston.	W. C. Pease, Somers.	36.00
10487	Essex Potato Fertilizer.	Russia Cement Co., Gloucester, Mass.	C. N. Jones, Wallingford.	33.00
			L. A. Carrier, Berlin.	34.00
			Southington Lumber & Feed Co., Southington.	32.00
			J. M. White, Bristol.	35.00
			F. L. Hitchcock, Watertown.	35.00
			T. Anderson & Co., Cromwell.	35.00

SPECIAL MANURES.

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ANALYSES AND VALUATIONS.—*Continued.*

Valuation per ton.	Percentage difference between cost and valuation.	NITROGEN.					PHOSPHORIC ACID.					POTASH.				
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.		Guaranteed.
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	
\$21.99	45.5	.....	3.50	3.50	3.3	3.71	3.27	2.14	9.12	....	6.98	6.0	0.53	5.45	5.4	
27.42	45.9	....	0.18	4.66	4.84	4.9	4.82	1.32	0.37	6.51	....	6.14	6.0	0.69	8.42	8.0
23.97	46.0	0.84	....	2.67	3.51	3.3	3.08	6.13	1.87	11.08	9.0	9.21	8.0	6.93	6.93	7.0
23.86	46.7	1.45	....	2.01	3.46	3.6	3.07	5.54	2.53	11.14	8.0	8.61	....	7.36	7.36	7.0
22.37	47.5	1.54	0.48	1.18	3.20	2.5	4.35	7.40	1.57	13.32	12.0	11.75	8.0	0.69	3.36	2.5
24.24	48.5	.....	3.89	3.89	3.3	5.73	1.62	0.76	8.11	9.0	7.35	8.0	0.88	6.72	6.0	
25.37	49.8	2.84	....	2.83	5.67	4.8	2.34	4.18	2.06	8.58	6.0	6.52	4.0	3.73	4.36	6.0
23.68	49.9	0.78	0.44	2.08	3.30	3.3	6.27	3.01	1.12	10.40	9.0	9.28	8.0	7.17	7.17	7.0
24.68	49.9	0.50	....	1.87	2.37	1.7	2.32	4.16	1.52	8.00	7.0	6.48	5.0	1.09	12.27	10.0
22.65	50.1	0.18	0.84	1.86	2.88	2.5	5.52	4.89	0.68	11.09	10.0	10.41	8.0	6.43	6.43	6.0
19.97	50.2	0.26	....	1.02	1.28	1.6	6.86	5.81	1.39	14.06	....	12.67	8.0	5.94	5.94	3.0
19.92	50.6	....	0.44	2.34	2.78	2.0	2.26	5.34	3.38	10.98	8.0	7.60	7.0	4.81	5.21	4.0
31.82	50.8	3.05	....	2.81	5.86	5.8	....	4.83	3.98	8.81	6.0	4.83	4.0	0.60	10.66	10.0
24.52	50.9	2.35	....	1.58	3.93	4.8	4.37	4.14	1.83	10.34	6.0	8.51	4.0	3.00	6.47	6.0
22.44	51.5	0.20	....	2.71	2.91	2.3	1.63	6.96	4.56	13.15	....	8.59	6.0	6.43	6.43	6.0
18.05	52.4	0.21	....	2.04	2.25	2.0	7.02	2.44	1.84	11.30	11.0	9.46	6.0	3.27	3.27	3.0
23.59	52.6	1.88	....	1.56	3.44	3.3	4.37	4.37	1.43	10.17	9.0	8.74	8.0	7.45	7.45	7.0
22.26	52.7	0.38	....	2.38	2.76	2.3	6.02	3.08	2.22	11.32	9.0	9.10	....	0.46	5.91	5.0

SPECIAL MANURES SAMPLED BY THE STATION.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.
10584	Stockbridge Corn.	Bowker Fertilizer Co., Boston.	Sanford & Hawley, Unionville.	\$37.00
			Jacob Blakeslee, Watertown.	38.00
10681	Special Potato Manure.	Crocker Fertilizer Co., Buffalo, N. Y.	C. T. Leonard, Norwalk.	39.00
10597	Tobacco Fertilizer.	Bradley Fertilizer Co., Boston.	F. M. Loomis, North Granby.	36.00
			D. T. Dyer, Collinsville.	37.00
10564	High Grade Special.	Williams & Clark, New York.	C. K. & H. T. Hale, Gildersleeve.	38.00
			G. H. Sloan, Windsorville.	37.50
			John Bransfield, Portland.	38.00
			Gault Bros., Westport.	36.00
10520	Tobacco Starter.	Bowker Fertilizer Co., Boston.	W. C. Pease, Somers.	37.00
			Bowker's Branch, Hartford.	36.00
10612	Potato Phosphate.	Cleveland Dryer Co., Boston.	E. F. Miller, Ellington.	35.00
			A. H. Bates, Windham Center.	33.00
			C. E. Main, Plainfield.	26.00
10606	Special Potato Fertilizer.	Lister's Agricultural Chemical Works, Newark, N. J.	A. W. Hutchinson, Gilead.	30.00
			J. C. Leonard & Son, Jewett City.	28.00
10451	Complete Manure for Top Dressing Grass and Grain.	Bradley Fertilizer Co., Boston.	W. B. Martin, Rockville.	27.00
			W. H. Scott, Pequabuck.	36.00
10336	Lowell Bone Fertilizer for Corn and Grain.	Lowell Fertilizer Co., Boston.	C. K. & H. T. Hale, Gildersleeve.	35.00
			J. C. Lincoln, Berlin.	35.50
			C. W. Lines, New Britain.	25.00
10562	High Grade Fruit Fertilizer.	M. E. Wheeler & Co., Rutland, Vt.	C. W. Lines, New Britain.	28.00
			J. F. Blakeslee, North Haven.	26.50
			L. B. Morgan, Plainfield.	28.00
10635	Americus Potato Manure.	Williams & Clark, New York.	R. B. Ritter, Brooklyn.	24.00
			E. F. Strong, Colchester.	26.00
			John Bransfield, Portland.	27.00
10355	Chittenden's Potato Phosphate.	National Fertilizer Co., Bridgeport.	John Bransfield, Portland.	30.00
			Manufacturer.	28.50
			G. A. & H. B. Williams, East Hartford.	32.00
10615	Vegetable, Vine, and Tobacco.	Great Eastern Fertilizer Co., Rutland, Vt.	J. F. Buckhout, Greenwich.	31.00
			A. G. Beach, Seymour.	34.00
			H. S. Harvey, Windham Center.	30.00
10333	Vegetable, Vine, and Potato Manure.	H. J. Baker & Bro., New York.	W. M. Tyler, Waterbury.	32.00
			Silas Finch, Greenwich.	32.00
10470	Bowker's Potato and Vegetable.	Bowker Fertilizer Co., Boston.	Lockwood & Palmer, Stamford.	35.00
			The Meeker Coal Co., Norwalk.	34.00
			C. T. Leonard, Norwalk.	34.50
			Bowker's Branch, Hartford.	36.00
				35.00

ANALYSES AND VALUATIONS.—*Continued.*

Valuation per ton.	Percentage difference between cost and valuation.	NITROGEN.						PHOSPHORIC ACID.						POTASH.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.		
					Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
\$24.78	53.3	0.75	....	2.72	3.47	3.0	7.01	2.45	1.25	10.71	10.0	9.46	....	7.58	7.58	6.0
23.46	53.5	...	1.86	2.08	3.94	3.7	7.10	1.87	0.19	9.16	....	8.97	8.0	5.25	5.25	5.0
24.41	53.6	0.95	.40	2.33	3.68	3.4	4.26	4.96	1.50	10.72	10.0	9.22	8.0	6.94	6.94	4.0
23.89	54.9	1.10	.26	2.13	3.49	3.3	3.01	6.00	1.83	10.84	9.0	9.01	8.0	7.18	7.18	7.0
22.26	57.2	0.38	....	2.40	2.78	2.3	9.34	1.86	1.41	12.61	12.0	11.20	8.0	0.41	4.15	3.0
17.76	57.7	0.23	....	1.98	2.21	2.1	6.75	2.82	1.55	11.12	....	9.57	8.0	3.13	3.13	3.0
16.95	59.3	....	....	1.96	1.96	1.7	6.06	3.37	1.34	10.77	9.0	9.43	8.0	3.00	3.22	3.0
22.25	59.6	5.26	....	....	5.26	4.3	2.88	3.72	1.05	7.65	6.0	6.60	5.0	0.56	2.66	2.5
16.40	61.6	....	....	1.96	1.96	1.7	6.64	1.93	1.27	9.84	9.0	8.57	8.0	3.39	3.39	3.0
16.04	62.1	....	....	....	....	....	8.26	2.54	0.70	11.50	12.0	10.80	10.0	6.94	7.34	8.0
17.46	63.2	0.26	....	1.92	2.18	2.0	5.89	3.39	1.80	11.08	9.0	9.28	8.0	3.14	3.14	3.0
19.56	63.6	....	0.56	1.54	2.10	2.0	3.55	2.95	0.80	7.30	8.0	6.50	6.0	3.88	8.38	10.0
19.54	63.8	....	..	2.23	2.23	2.0	6.59	2.17	1.10	9.86	....	8.76	8.0	6.11	6.11	6.0
21.04	64.0	...	0.78	1.10	1.88	1.7	5.54	0.84	0.44	6.82	6.5	6.38	5.5	11.69	11.69	12.0
19.43	64.7	0.26	...	2.58	2.84	2.3	6.58	1.90	1.20	9.68	10.0	8.48	8.0	4.25	4.25	4.0

SPECIAL MANURES SAMPLED BY THE STATION.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.
10711	Complete Tobacco Manure.	H. J. Baker & Bro., New York.	Wm. Stevenson, South Glastonbury.	\$42.00
10587	Corn Phosphate.	Bowker Fertilizer Co., Boston.	H. E. Daniels, New London.	26.00
10709	Americus Corn Phosphate.	Williams & Clark, New York.	C. F. Boswell, Preston.	28.00
10622	Animal Corn Fertilizer.	Packer's Union Fertilizer Co., New York.	Rockville Milling Co., Rockville.	29.00
			T. A. Tillinghast, Brooklyn.	28.00
			A. S. Bennett, Cheshire.	32.00
				30.00
10752	*Vegetable and Vine.	Read Fertilizer Co., New York.	J. L. Rice, Beacon Falls.	31.00
			N. L. Parmalee, Killingworth.	32.00
				31.50
10563	Havana Tobacco Grower.	M. E. Wheeler & Co., Rutland, Vt.	John Bransfield, Portland.	38.00
			E. E. Pitney, Ellington.	37.00
				37.50
10601	Complete Manure for Corn and Grain.	Bradley Fertilizer Co., Boston.	C. M. Beach, New Milford.	38.00
10450	Potato Fertilizer.	Bradley Fertilizer Co., Boston.	D. L. Clark, Milford.	29.00
			Wilson & Burr, Middletown.	32.00
				30.00
10532	Potato Special.	Pacific Guano Co., Boston.	Carlos Bradley & Son, Ellington.	28.00
			John Bransfield, Portland.	30.00
			Jas. A. Nichols, Danielson.	32.00
10339	High Grade Potato Manure.	Packer's Union Fertilizer Co., New York.	H. L. Hall, Wallingford.	35.00
			A. S. Bennett, Cheshire.	32.00
				33.50
10731	Potato Manure.	Bradley Fertilizer Co., Boston.	C. K. & H. T. Hale, Gildersleeve.	33.00
			H. S. Harvey, Windham Center.	31.00
				32.00
10613	Ammoniated Wheat and Corn Phosphate.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	H. F. Cady, Stafford.	31.00
			C. F. Tallard & Son, Broad Brook.	29.00
			H. Davis, Durham Center.	26.00
10849	Potato Manure.	Bradley Fertilizer Co., Boston.	Wheeler & Howe, Bridgeport.	33.00
			D. L. Clark, Milford.	30.00
			E. E. Scoville, Stamford.	34.00
				32.00
10621	Potato Phosphate.	Quinnipiac Co., Boston.	H. S. Coe, Harwinton.	31.00
			C. A. Young, Danielson.	30.00
10535	Northern Corn Special.	Great Eastern Fertilizer Co., Rutland, Vt.	J. N. Saunders, North Stamford.	35.00
			C. A. Sanderson, Moosup.	30.00
				32.50
10629	Corn Fertilizer.	Milsom Rend. & Fertilizer Co., E. Buffalo, N. Y.	Charles H. Davis, Guilford.	28.50
10594	Fish and Potash, Triangle A Brand.	Bradley Fertilizer Co., Boston.	I. J. Scoville, Plainville.	30.00
			C. F. Tallard & Son, Broad Brook.	29.00

ANALYSES AND VALUATIONS.—*Continued.*

Valuation per ton.	Percentage difference between cost and valuation.	NITROGEN.						PHOSPHORIC ACID.						POTASH.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Total Nitrogen.			Reverted.	Insoluble.	Total.		Available.		As Murate.	Found.	
					Found.	Guaranteed.	Soluble.			Found.	Guaranteed.	Found.	Guaranteed.		Total.	Guaranteed.
\$25.45	65.0	0.43	1.82	2.59	4.84	7.5	5.63	0.59	0.32	6.54	...	6.22	4.0	7.42	7.42	10.0
15.70	65.6	0.12	...	1.70	1.82	1.5	5.97	2.95	2.33	11.25	11.0	8.92	8.0	2.32	2.32	2.0
16.91	65.6	...	...	2.15	2.15	2.1	5.36	4.26	2.47	12.09	10.0	9.62	9.0	1.96	1.96	1.5
18.09	65.8	...	0.29	2.57	2.86	2.5	6.37	2.53	1.18	10.08	...	8.90	8.0	2.19	2.19	2.0
18.89	66.8	0.04	...	1.90	1.94	1.7	5.50	2.21	0.96	8.67	7.0	7.71	6.0	7.50	7.50	8.0
22.45	67.0	...	...	3.08	3.08	2.9	5.54	2.32	1.22	9.08	...	7.86	6.0	7.63	7.63	7.0
22.72	67.3	...	0.75	2.61	3.36	3.3	5.20	6.82	1.85	13.87	13.0	12.02	12.0	2.86	2.86	3.0
17.88	67.8	...	...	2.17	2.17	2.1	5.20	4.18	2.75	12.13	11.0	9.38	9.0	3.15	3.15	3.3
17.86	68.0	0.18	...	1.98	2.16	2.1	6.08	3.53	2.17	11.78	9.0	9.61	8.0	3.16	3.16	3.0
19.94	68.0	...	...	2.29	2.29	2.1	7.02	1.94	1.06	10.02	...	8.96	8.0	6.16	6.16	6.0
19.02	68.2	...	0.22	2.52	2.74	2.5	3.79	3.15	2.68	9.62	8.0	6.94	6.0	5.11	5.11	5.0
17.22	68.4	...	...	2.28	2.28	2.0	7.49	3.10	0.60	11.19	...	10.59	10.0	1.62	1.62	1.6
18.83	69.9	...	0.20	2.42	2.62	2.5	3.47	3.38	2.71	9.56	9.0	6.85	6.0	5.10	5.10	5.0
18.15	70.8	...	...	2.26	2.26	3.1	4.86	5.12	2.16	12.14	9.0	9.98	8.0	2.93	2.93	3.0
18.96	71.4	...	0.28	2.82	3.10	3.0	6.93	2.10	1.15	10.18	...	9.03	8.0	2.23	2.23	2.0
16.51	72.6	...	...	2.26	2.26	2.5	6.40	2.43	1.84	10.67	9.0	8.83	8.0	2.05	2.05	2.0
16.77	72.9	...	0.32	2.14	2.46	2.0	2.72	3.19	1.92	7.83	6.0	5.91	...	4.84	4.84	4.0

SPECIAL MANURES SAMPLED BY THE STATION.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.
10421	Potato Manure.	Quinnipiac Co., Boston.	C. Buckingham, Southport. Adams & Canfield, Winthrop.	\$30.00 32.00
10489	Special Potato Fertilizer.	Milsom Rendering & Fertilizer Co., East Buffalo, N. Y.	Olds & Whipple, Hartford. Charles H. Davis, Guilford.	34.00 31.00
10494	Potato, Hop, and Tobacco Phosphate.	Crocker Fertilizer Co., Buffalo, N. Y.	D. E. Doolittle, West Cheshire. Haley & Chesebro, Stonington. H. C. Porter, Hebron.	32.00 31.00 33.00
10518	High Grade Special Potato.	E. Frank Coe Co., New York.	H. B. Sherwood, Southport.	32.00
10636	Potato Phosphate.	Williams & Clark, New York.	J. O. Fox, Putnam. D. B. Wilson, Waterbury. T. B. Atwater, Plantsville	38.00 30.00 35.00
10527	Corn Fertilizer.	M. E. Wheeler & Co., Rutland, Vt.	J. F. Blakeslee, North Haven. C. I. Harvey & Son, Middletown.	32.50 30.00 28.00
10773	*Wheat, Oats, and Barley.	Milsom Rend. & Fertilizer Co., E. Buffalo, N. Y.	C. K. Ranney, Cromwell. G. C. Ingham, Saybrook. Dwight Gallup, Old Mystic.	28.50 30.00 28.00
10517	Potato Fertilizer.	Clark's Cove Fertilizer Co., New York.	L. B. Morgan, Plainfield. J. A. Loomis, Manchester	25.00 25.00
10664	*Vegetable and Vine.	Read Fertilizer Co., New York.	F. A. Hunt, Columbia. J. M. Burke, Manchester. J. R. Ballard, Thompson.	30.00 32.00 32.00
10531	Grass and Grain Fertilizer.	Pacific Guano Co., Boston.	J. N. Clark, Columbia.	31.50 32.00
10651	Special for Potatoes.	Standard Fertilizer Co., Boston.	Jas. A. Nichols, Danielson. Carlos Bradley & Son, Ellington.	26.00 24.00 25.00
10529	Corn Manure.	Quinnipiac Co., Boston.	W. E. Truesdell & Co., Burnside.	32.00
10476	Universal Grain Grower.	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	S. V. Osborn & Co., Branford. C. A. Young, Danielson. W. C. Pease, Somers.	30.00 29.00 30.00
10702	Wheat, Oats, and Clover Fertilizer.	Packers' Union Fertilizer Co., New York.	Clark & Bradley, North Westchester. Henry Davis, Durham Center.	22.00 22.00
10468	Potato and Vegetable Phosphate.	Bowker Fertilizer Co., Boston.	A. S. Bennett, Cheshire. Rockville Milling Co., Rockville. H. L. Hall, Wallingford.	22.00 24.00 22.00
			D. B. Wilson, Waterbury. J. C. Lincoln, Berlin. Linsley & Lightbourn, New Haven.	30.00 30.00 35.00

ANALYSES AND VALUATIONS.—*Continued.*

Valuation per ton.	Percentage difference between cost and valuation.	NITROGEN.			PHOSPHORIC ACID.					POTASH.				
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Total Nitrogen.		Soluble.	Reverted.	Insoluble.	Total.		Available.		Found.	
				Found.	Guaranteed.				Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.
\$18.46	73.3	0.53	....	2.15	2.68	2.5	1.07	5.91	2.14	9.12	7.0	6.98	6.0	5.30
17.84	73.8	....	....	1.50	1.50	1.6	5.49	2.36	0.96	8.81	10.0	7.85	8.0	7.56
18.37	74.2	....	....	2.24	2.24	2.0	5.66	4.15	1.49	11.30	....	9.81	10.0	3.63
21.72	75.0	....	0.89	1.74	2.63	2.4	6.32	2.03	2.64	10.99	9.0	8.35	7.0	6.03
18.45	76.1	0.68	....	1.99	2.67	2.5	.75	6.31	1.91	8.97	7.0	7.06	6.0	5.35
16.09	77.1	....	....	2.04	2.04	1.6	6.67	2.41	1.08	10.16	....	9.08	8.0	2.37
14.05	77.9	....	....	1.40	1.40	1.2	5.68	3.03	2.56	11.27	9.0	8.71	8.0	1.65
17.68	78.2	....	....	2.10	2.10	2.1	6.72	2.89	1.74	11.35	9.0	9.61	8.0	3.22
17.69	80.9	....	....	1.84	1.84	1.7	5.78	1.54	0.60	7.92	7.0	7.32	6.0	6.90
13.60	83.8	....	....	1.21	1.21	0.8	6.66	2.70	1.68	11.04	8.0	9.36	7.0	1.64
17.29	85.1	....	....	2.02	2.02	2.0	4.83	4.55	2.57	11.95	9.0	9.38	8.0	3.07
16.17	85.5	....	....	2.12	2.12	2.1	7.55	2.26	1.01	10.82	10.0	9.81	9.0	1.43
11.82	86.1	....	....	0.92	0.92	0.8	4.45	2.99	0.90	8.34	....	7.44	7.0	2.92
11.82	86.1	....	....	....	....	7.04	4.38	1.00	12.42	....	11.42	11.0	1.86	1.86
16.12	86.1	0.21	....	1.67	1.88	1.5	6.34	2.76	3.00	12.10	10.0	9.10	8.0	2.08

SPECIAL MANURES SAMPLED BY THE STATION.

Station No.	Name of Brand.	Manufacturer.	Dealer.	Dealer's cash price per ton.
10561	Potato Manure.	M. E. Wheeler & Co., Rutland, Vt.	G. C. Ingham, Saybrook. John Bransfield, Portland. C. K. Ranney, Cromwell. F. E. Larrabee, Marion. J. F. Blakeslee, North Haven.	\$34.00 34.00 31.00 33.00 32.00
10522	Corn Phosphate.	Bradley Fertilizer Co., Bos- ton.	W. W. Sheldon, South Woodstock. Quinnebaug Store, Daniel- son. W. H. Scott, Pequabuck.	30.00 33.00 29.00 31.00
10453	Potato, Hop, and Tobacco Fertilizer.	Niagara Fertilizer Co., Buffalo, N. Y.	Wm. Higgins, New London. W. R. Atwell, Durham.	30.00 30.00
10490	Potato, Hop, and Tobacco Phosphate.	Milsom Rend. & Fertilizer Co., E. Buffalo, N. Y.	D. E. Doolittle, West Cheshire.	30.00
10665	Grass Fertilizer.	Quinnipiac Co., Boston.	Chas. H. Davis, Guilford. Bailey & Markham, Cobalt.	29.50 35.00
10690	Grain and Grass Grower.	Niagara Fertilizer Works, Buffalo, N. Y.	Wm. Higgins, New Lon- don.	23.00
10703	Grass and Oats Fertilizer.	M. E. Wheeler & Co., Rutland, Vt.	G. C. Ingham, Saybrook.	24.00
10630	Practical Potato Special.	Read Fertilizer Co., New York.	Pascoe Bros., Winsted. J. R. Babcock, Mystic. J. W. Palmer, Stamford.	28.00 28.00 32.00
10730	*Wheat and Corn Pro- ducer.	Niagara Fertilizer Co., Buffalo, N. Y.	J. W. Cutler, Putnam.	28.00
10694	†Wheat, Oats, and Barley Phosphate.	Milsom Rend. & Fertilizer Co., E. Buffalo, N. Y.	D. E. Doolittle, West Cheshire.	26.00
10417	*Wheat and Corn Pro- ducer.	Niagara Fertilizer Co., Buffalo, N. Y.	Wm Higgins, New London. W. R. Atwell, Durham. C. A. Ahlquist, Portland.	26.00 30.00 30.00 29.00
10536	Grass and Oats Phosphate.	Great Eastern Fertilizer Co., Rutland, Vt.	C. A. Sanderson, Moosup. H. S. Harvey, Windham Center. J. N. Saunders, North Stamford.	25.00 21.00 28.00

* See page 65.

† See page 64.

ANALYSES AND VALUATIONS.—*Continued.*

Valuation per ton.	Percentage difference between cost and valuation.	NITROGEN.						PHOSPHORIC ACID.						POTASH.		
		Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen Organic.	Total Nitrogen.			Reverted.	Insoluble.	Total.		Available.		Found.		
					Found.	Guaranteed.	Soluble.			Found.	Guaranteed.	Found.	Guaranteed.	As Muriate.	Total.	Guaranteed.
\$17.61	87.4	.....	.....	2.33	2.33	2.06	6.62	2.15	1.13	9.90	....	8.77	8.0	3.48	3.48	3.8
16.49	88.0	.....	.....	2.14	2.14	2.16	5.53	3.28	1.91	11.72	10.0	9.81	9.0	1.46	1.46	1.5
15.91	88.6	.....	.....	2.02	2.02	1.65	5.95	2.97	0.70	9.62	8.0	8.92	....	2.62	2.62	2.7
15.86	89.2	.....	.....	1.88	1.88	2.15	5.42	2.36	1.10	8.88	9.0	7.78	8.0	3.99	3.99	4.0
18.49	89.3	....	4.05	0.02	4.07	3.93	3.92	1.53	0.84	6.29	6.0	5.45	5.0	2.35	2.35	2.0
11.80	94.9	.....	1.36	1.36	0.83	3.54	4.23	1.24	9.01	....	7.77	7.0	1.08	1.08	1.08	1.0
12.25	95.9	.....	.....	.....	.....	7.26	4.49	1.07	12.82	....	11.75	11.0	2.00	2.00	2.00	3.0
13.83	102.5	.....	.....	1.06	1.06	0.82	2.85	1.98	0.65	5.48	5.0	4.83	4.0	7.59	7.59	8.0
13.61	105.7	.....	.....	1.48	1.48	1.85	5.36	3.34	0.55	9.35	....	8.70	8.0	2.02	2.02	2.2
12.13	114.3	.....	.....	1.28	1.28	1.24	4.93	2.35	1.96	9.24	9.0	7.28	8.0	1.70	1.70	2.0
13.46	115.4	...	.....	1.50	1.50	1.25	5.44	2.96	0.64	9.04	8.0	8.40	....	2.03	2.03	2.1
11.58	115.9	.....	.....	.....	.....	7.41	3.62	0.97	12.00	....	11.03	11.0	1.91	1.91	1.91	2.0

2 and 3. Special Manures Sampled by Manufacturers and Purchasers.

The three samples described below were sent for analysis by purchasers.

10364. Scientific Potato Fertilizer. Made by the Scientific Fertilizer Co., Pittsburg, Pa. Sampled and sent by R. K. Woodward, Amenia Union, N. Y.

10406. Special Soluble Potato and Onion Manure. Made by J. G. Downward & Co., Coatesville, Pa. Sampled and sent by J. H. Thomas, Southport.

10725. Mapes Tobacco Starter. Made by the Mapes Formula and Peruvian Guano Co., N. Y. Sampled and sent by C. J. Dewey, Buckland.

ANALYSES.

	10364	10406	10725
Nitrogen of nitrates.....	....	0.62	1.83
" ammonia. ....	....	1.00	0.20
" organic.....	2.98	1.99	1.09
Total Nitrogen found.....	2.98	3.61	3.12
" <i>guaranteed</i> ..	3.0	4.0	2.5
Soluble Phosphoric Acid.....	3.82	5.14	4.26
Reverted " "	4.66	2.87	6.60
Insoluble " "	1.78	1.25	1.87
Total Phosphoric Acid found	10.26	9.26	12.73
" " <i>guaranteed</i>	9.0	8.0	12.0
Potash as muriate.....	0.44	5.46	0.52
" sulphate.....	5.29	....	2.79
Total Potash found.....	5.73	5.46	3.31
" <i>guaranteed</i>	6.0	6.0	2.5
Cost per ton.....	\$23.00	\$28.00	\$35.00
Valuation per ton... ..	....	22.05	21.46

The organic nitrogen of the Special Soluble Potato and Onion Manure, **10406**, made by J. G. Downward & Co., is soluble in acid pepsin solution to the extent of 75.9 per cent., indicating that it is readily available to plants.

Inferior Forms of Nitrogen.

The nitrogen of the Scientific Potato Fertilizer, **10364**, is apparently of quite inferior agricultural value, as only 33.5 per cent. of it is soluble in acid pepsin solution. For this reason no valuation is attached, as a valuation presupposes that the nitrogen of the fertilizer is derived from animal and vegetable matters which are quickly and fully available.

HOME MIXTURES.

In the following table are analyses of twenty-four mixtures made by the persons named, for their own use. With the analyses are given the formulas by which they were compounded.

The cost price named does not include the cost of mixing, usually estimated at from one to two dollars per ton. If two dollars per ton were added to the cost of these mixtures, for mixing, their average cost per ton would be \$27.94, their average valuation \$25.05, and the percentage difference between cost and valuation, 11.5. The economy of home mixing as compared with buying factory-mixed goods is discussed on page 99.

HOME MIXTURES, FORMULAS (18)

		FORMULAS, POUNDS PER TON OF MIXTURE.													
Station No.	Made by	Nitrate of Soda.	Sulphate of Ammonia.	Cotton Seed Meal.	Dry Ground Fish.	Ground Bone.	Dissolved Bones.	Tankage.	Dissolved Bone Black.	Acid Phosphate.	Muriate Potash.	Sulphate Potash, High Grade.	Sulphate Potash, Low Grade.	Wood Ashes.	Kainit.
10416	F. T. Bradley, Saybrook.	...	...	...	...	...	...	1700	...	300	...	...	...	...	...
10375	D. Fenn, Milford.	198	...	...	...	...	...	790	790	222	...	...	...	...	...
10726	C. J. Dewey, Buckland.	125	...	...	...	...	...	750	750	200	...	200	...	...	...
10497	P. K. Hoadley, No. Guilford.	100	300	...	...	800	...	...	...	300	500	...	...	...	...
10387	W. B. Miller, Middlefield.	...	...	...	...	...	...	...	...	...	...	...	...	...	...
10516	E. E. Burwell, New Haven.	...	...	...	...	...	...	...	...	...	...	...	...	...	...
10515	E. E. Burwell, New Haven.	...	...	...	...	...	...	...	...	...	...	...	...	...	...
10247	S. D. Woodruff & Sons, Orange.	100	...	...	...	...	...	800	...	800	300	...	...	...	...
10575	L. Sanderson, for N. D. Platt.	200	...	...	...	300	...	700	700	100	...	...	...	...	...
10576	L. Sanderson, for N. D. Platt.	200	...	...	...	300	...	700	700	100	...	...	...	...	...
10577	L. Sanderson, for N. D. Platt.	100	66	...	...	167	...	667	667	166	...	167	...	...	...
10465	F. B. Northam, Cobalt.	300	...	...	...	...	...	*400	...	700	...	400	...	...	...
10455	Clifton Peck, Yantic.	...	...	...	...	...	...	1266	...	200	534	...	...	...	...
10456	Clifton Peck, Yantic.	552	...	...	...	...	...	207	...	1241	...	...	...	...	...
10454	Clifton Peck, Yantic.	210	...	...	...	...	...	737	...	737	316	...	...	...	...
10457	Clifton Peck, Yantic.	200	...	...	...	...	...	800	...	800	200	...	...	...	...
10501	C. B. Pomeroy, Jr., Williamantic.	...	1000	...	...	...	...	...	...	700	300	...	...	...	...
10434	L. Sanderson, for George F. Platt & Son.	200	...	...	...	200	...	800	800	...	...	...	...	...	...
10435	L. Sanderson, for George F. Platt & Son.	200	...	...	...	200	...	700	700	200	...	...	...	...	...
10290	J. P. O'Connor, Wethersfield.	300	...	...	250	200	...	600	...	...	...	...	600	50	...
8996	E. E. Burwell, New Haven.	150	75	...	...	...	1265	...	...	...	...	510	...	...	...
10551	A. C. Lake, Bethlehem.	150	...	...	...	900	...	...	...	500	275	175	...	...	...
10550	A. C. Lake, Bethlehem.	140	...	...	...	...	...	785	...	700	200	175	...	...	...
10557	W. C. Pease, Somers.	857	...	...	...	572	...	...	...	...	...	...	...	...	57

* Also 200 pounds dried blood.

MISCELLANEOUS FERTILIZERS AND MANURES.

COTTON HULL ASHES.

In the tables on pages 84 and 85 are given analyses of 47 samples of this material which is extensively used as a source of potash for fertilizing tobacco lands in this State.

These analyses show the usual wide range of composition, especially as regards potash, the ingredient for which the ashes are bought.

ANALYSES AND VALUATIONS.

ANALYSES.								COST (UNMIXED) AND VALUATION.		
Nitrogen as Nitrates.	Nitrogen as Ammonia.	Nitrogen, Organic.	Total Nitrogen.	Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Total Phosphoric Acid.	Potash.	Cost Per Ton.	Valuation Per Ton.
		5.24	5.24				3.79	7.31		
1.40		2.23	3.63	6.98	4.04	.93	11.95	5.90	\$30.00	\$24.78
1.09		2.55	3.64	5.65	3.48	1.60	10.73	7.66	33.00	24.99
.67	2.89	.90	4.46	1.34	7.72	.56	9.62	12.46	32.75	30.55
1.72		2.30	4.02	3.25	2.56	1.05	6.86	7.07		22.32
.38		4.02	4.40	4.67	2.75	.36	7.78	3.13	23.75	21.45
.35	1.18	1.94	3.47	5.01	2.26	.55	7.82	8.68	29.45	24.48
.92		2.22	3.14	5.65	3.94	1.63	11.22	8.53	25.00	24.75
.96		2.80	3.76	4.90	8.93	2.76	16.59	1.88	26.50	24.59
.93		2.77	3.70	5.84	7.88	2.78	16.50	2.27	26.50	24.78
.61	.36	3.30	4.27	4.77	4.39	1.68	10.84	5.98	28.00	25.42
2.38		2.26	4.64	2.56	2.28	1.25	6.09	9.65		26.24
		3.60	3.60	.74	3.02	2.02	5.78	13.83	29.00	31.73
3.72		.74	4.46	6.67	2.88	1.07	10.62		23.00	20.47
1.35		2.49	3.84	3.33	3.83	1.68	8.84	7.14	25.00	23.28
1.20		2.43	3.63	3.74	3.48	2.12	9.34	4.68	25.00	20.90
		3.83	3.83	3.46	2.13	.99	6.58	8.81	22.60	23.42
1.80		1.92	3.72	8.98	3.21	.92	13.11		26.00	21.08
1.36		3.45	4.81	4.74	4.62	1.39	10.75	6.96	28.00	27.65
3.04		1.68	4.72	3.42	2.94	.91	7.27	7.70	24.98	25.88
1.38	.25	2.54	4.17	3.46	12.53	1.20	17.19	9.50	45.00	34.43
.81		1.52	2.33	4.32	6.57	4.82	15.71	10.66	28.50	26.99
1.02		2.44	3.46	5.07	2.60	.70	8.37	9.62	24.66	24.92
4.11		1.02	5.13				6.36	3.90	28.00	20.99

The highest percentage of potash was 31.09, the lowest, 15.08, while the average percentage was 23.3, slightly higher than the average in the previous year (22.4).

Allowing 4½, 4, and 2 cents per pound respectively for water-soluble, citrate soluble and insoluble phosphoric acid, the water-soluble potash has cost from 4.8 to 10.7 cents per pound, or 7.1 cents per pound on the average.

The average cost of potash per pound would have been considerably higher but for the fact that in most cases the ashes were bought of responsible dealers who gave a guarantee of the per cent. of potash, and when the ashes were shown by the

Station analysis to fall short of this guarantee, the dealers made a reduction of price. In making contracts the percentage of "water-soluble potash" should be guaranteed, not simply of "potash" without qualification. This Station bases its valuation on the water-soluble form only. Ashes contain more or less potash in form of silicates, which are quite insoluble and inferior or inert as plant food. Thus, in sample No. 10480 there was 19.58 per cent. of water-soluble potash, while the

COTTON HULL ASHES.

Station No.	Dealer or Purchaser.	Supplied by
10147	J. W. Walker & Co., Houston, Tex.,	C. D. Burbank, Thompsonville,
10268	W. S. Pinney, Suffield,	W. H. Prout, Suffield,
10360	W. S. Pinney, Suffield,	D. I. King, Windsor Locks,
10219	Olds & Whipple, Hartford,	Olin Wheeler, Buckland,
10821	Olds & Whipple, Hartford,	S. E. Wilcox, Hartford,
10358	Chas. L. Spencer, Suffield,	F. B. Hathaway, Windsor Locks,
10218	Olds & Whipple, Hartford,	
10573	Olds & Whipple, Hartford,	P. P. Hickey, Burnside,
10410	Olds & Whipple, Hartford,	John DuBon, Poquonock,
10291	Chas. L. Spencer, Suffield,	E. S. Seymour, Windsor Locks,
10504		Geo. C. Eno, Simsbury,
10480		John A. DuBon, Poquonock,
10111	Olds & Whipple, Hartford,	Frank S. Taylor, Hartford,
10182	Edmund Halladay, Suffield,	Edmund Halladay, Suffield,
10183	Edmund Halladay, Suffield,	Edmund Halladay, Suffield,
10382	Olds & Whipple, Hartford,	Station Agent,
10114	Olds & Whipple, Hartford,	Olin Wheeler, Buckland,
10180	Olds & Whipple, Hartford,	T. P. Kinney, Windsor,
10196	Olds & Whipple, Hartford,	F. L. Chandler, South Woodstock,
10112	Olds & Whipple, Hartford,	Olin Wheeler, Buckland,
10113	Olds & Whipple, Hartford,	Olin Wheeler, Buckland,
10321		Clinton Spencer, Suffield,
10320	W. W. Cooper, Suffield,	C. F. Tilden, Thompsonville,
10280	C. L. Spencer, Suffield,	S. O. Ranney, Windsor Locks,
10184	Olds & Whipple, Hartford,	A. E. Holcomb, Poquonock,
10221	Chas. L. Spencer, Suffield,	F. L. Woodworth, Thompsonville,
10195	W. S. Pinney, Suffield,	C. D. Woodworth, Thompsonville,
10151	W. S. Pinney, Suffield,	G. H. Harman, Suffield,
10368	Edmund Halladay, Suffield,	Edmund Halladay, Suffield,
10507	Olds & Whipple, Hartford,	Geo. Rengermann, East Granby,
10572	R. W. Cowles, Tariffville,	N. T. Case, Tariffville,
10324	W. S. Pinney, Suffield,	Pitcher & Phillips, Thompsonville,
10233	W. S. Pinney, Suffield,	G. A. Douglass, Thompsonville,
10431	Olds & Whipple, Hartford,	C. D. Cannon, Windsor Locks,
10110	Olds & Whipple, Hartford,	Frank S. Taylor, Hartford,
10505	Clinton Spencer, Suffield,	E. A. Pomeroy, Suffield,
10319	Edmund Halladay, Suffield,	Arthur H. Humason, Suffield,

total potash was 21.86 per cent. Sample No. 10321, contained 17.90 per cent. of water-soluble potash, but the total per cent. of potash was 20.80.

CORN-COB ASHES.

8999. Sent by J. A. DuBon. Sample from Chas. G. Eno, Osborn, Kansas. The ashes are stated to be procurable in some quantity in Kansas and neighboring states.

ANALYSES.

Soluble Phosphoric Acid.	Reverted Phosphoric Acid.	Insoluble Phosphoric Acid.	Total Phosphoric Acid.	Potash Soluble in Water.	Cost per Ton.	Valuation per Ton.	Potash Costs cents per pound.
.14	4.48	.74	5.36	29.24	\$32.00	\$23.25	4.8
1.73	8.48	.50	10.71	27.32	40.00	35.86	5.8
1.68	8.38	.49	10.55	26.88	40.00	35.29	5.9
2.85	6.75	.94	10.54	31.09	45.00	39.43	5.9
.54	7.83	.87	9.24	23.89	40.00	30.99	6.1
1.30	7.20	.63	9.13	26.86	40.00	34.04	6.1
2.14	11.77	.49	14.40	25.14	43.00	36.69	6.2
2.53	6.80	.72	10.14	29.76	45.00	37.84	6.2
.83	6.66	.72	8.21	19.98	31.50	26.35	6.3
2.40	8.90	.97	12.27	23.92	40.00	33.59	6.3
2.13	6.79	.65	9.57	29.88	45.00	37.49	6.3
1.30	6.39	.75	8.44	19.58	31.50	26.16	6.4
.53	11.01	.89	12.43	23.22	40.00	32.87	6.5
.66	6.06	1.16	7.88	24.08	38.00	29.98	6.7
1.44	6.17	1.51	9.12	22.82	38.00	29.66	6.8
1.54	7.55	.89	9.98	23.64	40.00	31.43	6.8
.76	9.43	2.35	12.54	25.00	43.00	34.16	6.8
.21	6.88	1.02	8.11	23.42	38.50	29.52	6.9
.69	7.04	.50	8.23	26.50	43.00	32.95	6.9
.40	8.42	.53	9.35	26.88	45.00	34.19	7.0
.35	8.61	.63	9.59	24.54	43.00	32.00	7.2
.46	3.83	1.33	5.62	17.90	30.00	21.90	7.3
.69	6.55	.81	8.05	23.08	40.00	29.26	7.3
2.00	9.34	1.06	12.40	20.30	40.00	29.99	7.4
.08	6.18	1.12	7.38	21.80	38.00	27.26	7.5
.69	6.99	1.06	8.74	22.24	40.00	28.87	7.5
.50	7.19	1.03	8.72	22.32	40.00	28.93	7.5
.54	7.47	1.09	9.10	20.30	38.00	27.21	7.6
.40	4.82	.78	6.00	22.58	39.00	27.11	7.6
trace	5.27	.51	6.78	24.90	43.00	30.12	7.6
1.38	6.87	.92	9.17	24.46	42.00	29.57	7.8
.48	7.45	1.05	8.98	20.64	40.00	27.45	8.0
.35	7.73	1.09	9.17	20.56	40.00	27.50	8.0
.21	7.39	.79	8.39	20.76	40.00	27.18	8.1
none	3.95	1.87	5.82	12.30	25.00	16.21	8.5
.24	3.77	1.11	5.12	19.46	40.00	23.14	9.3
.78	5.90	.94	7.62	15.08	38.00	20.88	10.7

ANALYSIS.

Water-soluble phosphoric acid, . . .	2.37 per cent.
Citrate " " " . . .	.97 "
Insoluble " " " . . .	.67 "
Potash soluble in water, . . .	21.13 "

These ashes contain about the same percentage of potash as cotton-hull ashes, but less than half as much phosphoric acid.

WOOD ASHES.

In the table, pages 88 and 89, are given nineteen analyses of wood ashes.

10130 is a sample from the Coe Brass Co. of Torrington. These ashes cost 15 cents per bushel of 45 pounds, from which is calculated the ton price, \$6.67.

The three samples sent by W. H. Olcott of So. Manchester represent ashes from heaps which have been leached by exposure to the weather.

The samples show the usual range of composition. Nearly a quarter of the weight of sample **10244** consists of sand and soil, "gathered" with the ashes, which explains the low percentage of potash. The low percentages of potash in samples **10509** and **10642** are explained in the same way.

Samples **10604**, **10605**, **10510**, and **10727** represent ashes of low grade and probably partly leached.

The average composition of unleached (and unsanded) ashes for the last four years has been:

	1895. 16 Samples.	1896. 22 Samples.	1897. 21 Samples.	1898. 9 Samples.
Potash, soluble in water, . . .	4 $\frac{1}{3}$	5 $\frac{1}{2}$	5 $\frac{1}{2}$	5 $\frac{1}{2}$
Phosphoric Acid, . . .	1 $\frac{1}{2}$	1 $\frac{1}{2}$	1 $\frac{1}{8}$	1 $\frac{1}{2}$
Lime,	34	32 $\frac{1}{2}$	32 $\frac{1}{2}$	36 $\frac{1}{2}$
Sand and soil, . . .	12 $\frac{1}{4}$	11	10 $\frac{1}{2}$	5
Charcoal,	2	2 $\frac{1}{2}$	2	1 $\frac{1}{3}$
Cost per ton,	\$10.75	\$10.36	\$10.30	\$9.45*

Ashes are sometimes sold with a guarantee of 5.0 per cent. of "potash." This Station, as a rule, determines only the potash soluble in water; for the reason that only potash which is freely soluble can be regarded as immediately available to vegetation. Green sand marl, felspar, and glass all may con-

* Excluding one exceptionally low price, the average is \$9.82.

tain considerable quantities of "potash," but in forms which yield it up to the roots of plants extremely slowly.

The lime contained in ashes is often their most valuable ingredient for agricultural purposes. A ton of unleached wood ashes, calculated from the average of the analyses given above contains 732 pounds of lime, 111 pounds of potash, and 30 pounds of phosphoric acid, costing \$9.82. Allowing 5 cents per pound each for potash and phosphoric acid, the pure lime (calcium oxide), in the nine samples, has cost thirty-eight cents for 100 pounds.

LIME-KILN ASHES.

The two samples, whose analyses appear in the table, p. 88, contained 31.38 and 40.48 per cent. of lime, respectively, with 1.06 and 0.99 per cent. of potash. Reckoned on the same basis as in the unleached ashes, pure lime in the one of these samples whose price is given, cost forty-eight cents per 100 pounds, ten cents more per hundred than in wood ashes.

OYSTER-SHELL LIME.

A single sample of this material is included in the table, page 88. The pure lime contained in it costs 81 cents per 100 pounds. The price quoted is at the rate charged for single barrel lots of 250 pounds.

SOURCES, ANALYSES, AND COST OF

Station No.	Dealer or Purchaser.	Sampled or sent by
<i>Wood Ashes.</i>		
10362	Allison Co., Fulton St., New York City.	Ernest N. Austin, Suffield,.....
10292	Bowker Fertilizer Co., Boston, per A. G. Smith, Wethersfield,.....	Jas. P. O'Connor, Wethersfield,.....
10107	F. R. Lalor, Dunville, Ont.,.....	John E. Frisbie, Southington,.....
10244	F. R. Lalor, Dunville, Ont.,.....	T. D. Barclay, Kent,.....
10284	F. R. Lalor, Dunville, Ont.,.....	G. A. Isbell, 708 Chapel St., N. Haven.
10604	F. R. Lalor, Dunville, Ont.,.....	H. C. C. Miles, Milford,.....
10605	F. R. Lalor, Dunville, Ont.,.....	Geo. F. Platt & Son, Milford,.....
10318	George Munroe, Oswego, N. Y.,.....	Earl Cooley, Berlin,.....
10342	George Munroe, Oswego, N. Y.,.....	Geo. W. Spicer, Deep River,.....
10839	George Munroe, Oswego, N. Y.,.....	Horace Hurlbutt, Weston,.....
10130	Coe Brass Co., Torrington,.....	Wm. J. Barber, Harwinton,.....
10509	T. Potts, Brantford, Ont.,.....	J. H. Hale, So. Glastonbury,.....
10642	Thomas Potts, Brantford, Ont.,.....	J. H. Hale, So. Glastonbury,.....
10004	Local Sawmill,.....	W. H. Olcott, So. Manchester,.....
10108	Local Sawmill,.....	W. H. Olcott, So. Manchester,.....
10152	Local Sawmill,.....	W. H. Olcott, So. Manchester,.....
10002	.....	Thomas L. Craik, Greenfield Hill,.....
10510	.....	A. E. Hollister, Glastonbury,.....
10727	Mr. Smith Wethersfield,.....	Thomas H. L. Tallcott, Glastonbury,.....
<i>Lime-kiln Ashes.</i>		
10376	East Canaan,.....	Daniels Bros., Middletown,.....
10848	A. S. Farnham & Bros., Cheshire, Mass.,.....	John W. Palmer, Stamford,.....
<i>Oyster-shell Lime.</i>		
10359	Edward Austen, Suffield,.....	F. B. Hathaway, Windsor Locks,.....

LAND PLASTER.

A sample, 10477, sent by A. H. Clark, Poquonock, drawn from stock of Olds & Whipple, Hartford, contained:

Water,	6.29 per cent.
Insoluble in acid, sand, etc.,	0.74 "
Calcium sulphate, hydrated (gypsum),	78.46 "
Calcium carbonate and other matters, by difference,	14.51 "
Total,	100.00

The cost is \$10 per ton.

This has the composition of Cayuga or Onondaga plaster. Nova Scotia plaster contains but little, if any, carbonate of lime.

WOOD ASHES AND OF LIME-KILN ASHES.

Potash Soluble in Water.	Phosphoric Acid.	Lime, Cal- cium Oxide.	Carbonic Acid.	Sand and Spl.	Charcoal.	Cost per ton.
4.41	1.26	28.45	17.31	7.06	0.88	\$9.50
6.60	1.18	31.99	17.61	3.49	0.98	10.00
5.22	1.28	46.51	22.54	3.40	0.64	10.50
2.99	1.46	28.90	16.38	23.17	2.76	10.00
5.70	1.30	39.79	19.44	3.86	1.12	9.50
3.17	1.13	34.65	20.78	3.39	1.30	10.00
2.84	1.13	37.14	23.38	3.34	1.67	10.00
7.13	1.66	35.76	21.27	6.39	1.31	10.00
5.35	1.41	34.46	21.09	6.20	1.25	10.00
5.02	1.32	34.35	20.67	4.60	1.52	9.50
4.56	2.44	37.95	28.24	2.60	3.10	6.67
2.99	1.25	23.54	14.29	19.60	3.27	8.00
3.16	1.60	27.74	18.10	20.49	3.54	8.00
0.85	0.79	14.43	8.18	*36.50	5.26	....
0.42	....	19.20	12.19	26.03	1.11	....
1.68	1.15	25.41	14.37	38.66	3.91	....
5.85	1.51	40.14	22.29	7.39	1.07	9.50
3.07	0.75	47.20	26.56	1.78	0.49	....
3.36	0.88	47.55	25.17	2.12	0.95	11.00
1.06	0.90	31.38	23.29	1.64	5.21	....
0.99	0.60	40.48	18.71	2.39	3.02	5.50
....	....	61.64	8.89	6.28	...	10.00

BAT GUANO.

10188. This material, sent by Olin Wheeler, Buckland, is found in caves where bats resort in large numbers. The sample had the following composition:

Bat Guano.	
10188	
Nitrogen as nitrates,	1.50
" Ammonia,	.58
" Organic,	2.87
Total Nitrogen found,	4.95
" guaranteed,	...

* Water, 26.93.

	Bat Guano.
Phosphoric Acid, soluble, . . . . .	.45
" reverted,	5.98
" insoluble,	4.93
Phosphoric Acid, total,	11.36
Potash as muriate, . . . . .	.49
" sulphate, . . . . .	.26
Total Potash found, . . . . .	.75
Chlorine, . . . . .	.20

The organic nitrogen of bat guano comes almost entirely from the chitinous wing-cases of insects and is known to be very inert as a fertilizer. It is almost entirely insoluble in pepsin solution.

STREET SWEEPINGS.

10129. A sample sent by P. P. Hickey, Burnside, is stated to consist of the sweepings from asphalt pavements in Hartford, offered as a manure.

The analysis is as follows:

Water,	14.48
Organic and Volatile matters,	10.70
Sand and Soil,	66.60
Other Mineral Matter,	8.22
	<hr/>
	100.00
In the Organic Matter, Nitrogen,	0.19
In the Mineral Matter, Phosphoric Acid,	0.15
Potash,	0.07

GROUND WEED SEED.

10154. A sample sent by A. N. Farnham, New Haven, contained:

Nitrogen,	2.72
Phosphoric Acid,	1.16
Potash,	0.87

This material is stated to be the ground residue left from the cleaning of grain, and it was proposed to use it in the compost heap.

ROTTED PEAT.

8997 and **8998**. Samples taken from a peat swamp in East Haven by E. E. Burwell of New Haven. The first represents the upper layer, taken between one foot and two and a half feet from the surface. The second was taken between two and four feet down.

ANALYSES.		
	8997	8998
Water,	35.54	34.18
*Organic Matter,	53.05	58.87
Mineral Matter, soluble in Acid,	7.01	6.55
" insoluble in Acid (sand and soil),	4.40	0.40
	<hr/> 100.00	<hr/> 100.00
*Containing Nitrogen,	1.85	1.41

The lower layer contains less sand and more organic matter (humus), but this has less nitrogen in it than the surface layer.

JADOO FIBER.

10003. Bought for experiment of the American Jadoo Fiber Co., Philadelphia. Cost, delivered, \$1.10 for a package containing 24 pounds of the material.

This is claimed to be "a new growing substance for plants of all kinds," made by boiling peat moss or other suitable fibrous or spongy material with a fertilizing composition, straining and partially fermenting the product. Its manufacture is covered by patent.

The sample bought of the company had the following composition:

Water,	71.57 per cent.
Organic Matter,	25.82 "
Sand and Soil,	0.59 "
Soluble Mineral Matter,	2.02
	<hr/> 100 00

The material contained 0.29 per cent. of nitrogen, 0.18 per cent. of phosphoric acid, and .09 per cent. of potash.

REVIEW OF THE FERTILIZER MARKET,

FOR THE YEAR ENDING OCTOBER 31, 1898.

BY E. H. JENKINS.

NITROGEN.

Nitric Nitrogen.

The *wholesale* New York quotation of nitrogen in this form in November, 1897, was 10.1 cents per pound. It rose at first gradually, and then sharply on account of the demand for the gunpowder manufacture and increased freight risks caused by the war, and was quoted in May, 1898, at 17.1 cents. It fell quickly thereafter to 9.1 cents in September, and rose in October to 9.6 cents per pound.

The average of the monthly quotations for a number of years — from November 1st to November 1st has been as follows:

Year,	1898	1897	1896	1895	1894	1893	1892	1891
Average quotation,								
Cents pr. lb., <i>wholesale</i> ,	11.0	11.4	11.1	11.4	13.0	12.7	12.1	12.9

The *retail* price of nitrogen in nitrate in this state at freight centers, as shown on page 22, has been about 13.5 cents per pound.

Ammonic Nitrogen.

The *wholesale* New York quotations of nitrogen in form of sulphate of ammonia have ranged during the year between 10.9 cents and 12.6 cents per pound. The average of the monthly quotations has been 11.9 cents.

The corresponding averages of previous years have been:

Year,	1898	1897	1896	1895	1894	1893	1892
Average quotation, <i>wholesale</i> ,							
sale, cents per pound, .	11.9	10.5	11.1	14.3	17.3	15.7	14.5

There is but little demand for sulphate of ammonia in the Connecticut retail market, and at *retail*, nitrogen in this form, as is seen on page 24, costs considerably more than nitrate, from 14.3 to 15.5 cents per pound.

Organic Nitrogen.

The *wholesale* New York quotations of nitrogen in the forms of red blood, black or low grade blood, and concentrated tankage for each month in the year are shown in the table on page 98. The fluctuations have not been large.

The nitrogen of red blood has cost at wholesale — the average of twelve months' quotations — 0.3 cent per pound more in 1898 than in 1897, that of black blood 0.2 cent more, and that of concentrated tankage 1.7 cents more.

These forms of organic nitrogen do not meet with much sale in our retail market.

Low grade tankage, fish, bone, and especially cotton-seed meal are the forms most used by those who mix their own fertilizers or apply fertilizers to their land unmixed.

Cotton-seed meal, as shown on page 25, has been the cheapest form of quickly-available organic nitrogen in our market.

PHOSPHATIC MATERIALS.

Rough bone, which was quoted at \$17.50 per ton wholesale in the winter months of 1898, rose to \$19 in June, at which price it has been quoted till November.

Bone meal was quoted November 1, 1898, at \$21.50 per ton, a dollar more than in November of 1897.

Sulphuric acid, 66° B. rose from .97½ in November, 1897, to 1.47½ in May, 1898, and has been quoted at that figure till the time of this writing, November, 1898.

Available phosphoric acid, in form of dissolved South Carolina phosphate, quoted at 2.53 cents per pound wholesale in November, 1897, fell in April, 1898, to 2.36 cents, but has risen since then to 3.13 cents per pound.

The figures given on page 28 show that available phosphoric acid *in form of dissolved bone black* has cost *at retail* in this state from 6.0 to 6.9 cents per pound, while *in form of dissolved rock phosphate* it has cost from 3.1 to 4.6 cents per pound.

POTASH.

Muriate of Potash.

The average monthly *wholesale* quotations of potash in this form have been 3.64 cents per pound, through the year, being fixed, like those of the other German potash salts, by the German Kali Works.

The retail price in Connecticut, as shown on page 31, has ranged from 3.8 to 4.5 cents per pound.

The Double Sulphate of Potash and Magnesia.

The average monthly *wholesale* quotation of potash in this form has been 4.09 cents per pound uniformly through the year.

The retail price of potash in this form in Connecticut, as appears on page 31, has ranged from 4.9 to 6.8 cents per pound.

High Grade Sulphate of Potash.

The average monthly *wholesale* quotation of potash in this form has been 4.10 cents per pound, uniformly through the year.

The retail price in Connecticut, as appears on page 31, has ranged from 4.6 to 5.1 cents per pound.

These quotations are taken from the "Oil, Paint, and Drug Reporter," published in New York. The weekly quotations for each month are averaged, and this average is taken as the quotation for the month.

The following explanations will help in the examination of the market quotations, and will also show the basis on which they have been interpreted in this review:

Phosphate rock, kainit, bone, fish-scrap, tankage, and some other articles, are usually quoted and sold by the ton. The seller usually has an analysis of his stock, and purchasers often control this by analysis at the time of the purchase.

Sulphate of ammonia, nitrate of soda, and the potash salts are quoted and sold by the pound, and generally their *wholesale* and *retail* rates do not differ very widely.

Blood, azotin, and concentrated tankage are quoted at so much "per unit of ammonia." To reduce ammonia to nitrogen, multiply the per cent. of ammonia by the decimal .824 (or multiply the per cent. of ammonia by 14 and divide that product by 17.) A "unit of ammonia" is one per cent., or 20 pounds per

ton. To illustrate: if a lot of tankage has 7.0 per cent. of nitrogen, equivalent to 8.5 per cent. of ammonia, it is said to contain $8\frac{1}{2}$ units of ammonia, and if quoted at \$2.25 per unit, a ton of it will cost $8\frac{1}{2} \times 2.25 = \19.13 .

The term "ammonia" is *properly* used only in those cases where the nitrogen actually exists in the form of ammonia, but it is a usage of the trade to reckon all nitrogen, in whatever form it occurs, as ammonia.

To facilitate finding the actual cost of nitrogen per pound from the cost per unit of ammonia in the market reports, the following table is given:

Ammonia at \$3.00 per unit is equivalent to nitrogen at 18.2 cts. per lb.

"	2.90	"	"	"	17.6	"
"	2.80	"	"	"	17.0	"
"	2.70	"	"	"	16.4	"
"	2.60	"	"	"	15.8	"
"	2.50	"	"	"	15.2	"
"	2.40	"	"	"	14.6	"
"	2.30	"	"	"	14.0	"
"	2.20	"	"	"	13.4	"
"	2.10	"	"	"	12.8	"
"	2.00	"	"	"	12.2	"
"	1.90	"	"	"	11.6	"
"	1.80	"	"	"	11.0	"
"	1.70	"	"	"	10.3	"
"	1.60	"	"	"	9.7	"
"	1.50	"	"	"	9.1	"

Commercial sulphate of ammonia contains about 20.8 per cent. of nitrogen, though it varies somewhat in quality. With that per cent. of nitrogen (equivalent to 25.25 per cent. of ammonia).

If quoted at 2.6 cents per pound, Nitrogen costs 12.5 cents per pound.

"	2.5	"	"	"	12.0	"
"	2.4	"	"	"	11.5	"
"	2.3	"	"	"	11.1	"
"	2.2	"	"	"	10.6	"
"	2.1	"	"	"	10.1	"
"	2.0	"	"	"	9.6	"

Commercial nitrate of soda averages 95 per cent. of pure sodium nitrate, or 16 per cent. of nitrogen.

If quoted at 2.5 cents per pound, Nitrogen costs 15.6 cents per pound.

"	2.4	"	"	"	15.0	"
"	2.3	"	"	"	14.4	"
"	2.2	"	"	"	13.8	"
"	2.1	"	"	"	13.2	"
"	2.0	"	"	"	12.5	"
"	1.9	"	"	"	11.9	"
"	1.8	"	"	"	11.3	"
"	1.7	"	"	"	10.6	"
"	1.6	"	"	"	10.0	"
"	1.5	"	"	"	9.4	"

Commercial Muriate of Potash usually contains $50\frac{1}{2}$ per cent. of "actual potash," or potassium oxide.

If quoted at 2.20 cents per pound, Potassium Oxide costs 4.35 cents per lb.

"	2.15	"	"	"	4.25	"
"	2.10	"	"	"	4.15	"
"	2.05	"	"	"	4.06	"
"	2.00	"	"	"	3.96	"
"	1.95	"	"	"	3.86	"
"	1.90	"	"	"	3.76	"
"	1.85	"	"	"	3.66	"
"	1.80	"	"	"	3.56	"
"	1.75	"	"	"	3.46	"
"	1.70	"	"	"	3.36	"

High Grade Sulphate of Potash, as it is found in the Connecticut market, contains about 49.2 per cent. of actual potash.

If quoted at 2.50 cents per pound, Potassium Oxide costs 5.1 cents per lb.

"	2.45	"	"	"	5.0	"
"	2.40	"	"	"	4.9	"
"	2.35	"	"	"	4.8	"
"	2.30	"	"	"	4.7	"
"	2.25	"	"	"	4.6	"
"	2.20	"	"	"	4.5	"
"	2.15	"	"	"	4.4	"
"	2.10	"	"	"	4.3	"
"	2.05	"	"	"	4.2	"
"	2.00	"	"	"	4.1	"

The Double Sulphate of Potash and Magnesia has about $26\frac{1}{2}$ per cent. of potassium oxide.

If quoted at 1.00 cents per pound, Potassium Oxide costs 3.77 cents per lb.

"	1.05	"	"	"	3 96	"
"	1.10	"	"	"	4.15	"
"	1.15	"	"	"	4.34	"
"	1.20	"	"	"	4.53	"
"	1.25	"	"	"	4.72	"
"	1.30	"	"	"	4.90	"

The following table shows the fluctuations in the wholesale prices of a number of fertilizing materials in the New York market, since November, 1894. The price given for each month is the average of the four weekly quotations for that month. Sulphate of ammonia is assumed to contain 20.8 per cent. and nitrate of soda 16.0 per cent. of nitrogen, muriate of potash 50½ per cent., high grade sulphate 49.2 per cent., and double manure salt 26.5 per cent. of actual potash.

WHOLESALE PRICES OF FERTILIZING MATERIALS.

		Cost of Nitrogen at wholesale in						Cost of Potash at wholesale in				Available Phosphoric Acid in Dissolved South Carolina Rock, Cent per pound.
		Dried Blood.										
		Red. Cents per pound.	Black or low grade Cents per pound.	Azotic or Ammonite. Cents per pound.	Concentrated Tankage. Cents per pound.	Nitrate of Soda. Cents per pound.	Sulphate of Ammonia. Cents per pound.	Muriate of Potash. Cents per pound.	Double Manure Salt. Cents per pound.	High Grade Sulphate of Potash. Cents per pound.		
1895.	November,	14.1	13.1	14.0	12.3	13.2	16.4	4.13	5.04	4.85	3.00	
	December,	13.5	12.4	13.1	12.3	12.9	16.0	4.13	5.04	4.85	3.10	
	January,	12.7	12.2	13.0	12.3	12.1	15.0	3.54	4.24	4.13	3.50	
	February,	11.9	11.2	.....	12.3	11.4	15.0	3.54	4.24	4.13	3.37
	March,	12.1	10.5	.....	12.3	10.4	15.0	3.59	4.32	4.20	3.37
	April,	11.7	10.6	.....	12.3	10.3	15.0	3.59	4.32	4.20	3.37
	May,	12.1	10.8	.....	12.3	10.5	14.3	3.59	4.32	4.20	3.37
	June,	11.7	10.9	.....	12.3	11.0	13.6	3.59	4.32	4.20	3.37
	July,	11.6	10.7	.....	12.3	10.9	13.4	3.60	4.32	4.20	3.37
	August,	11.5	10.2	.....	12.3	10.8	13.1	3.60	4.32	4.20	3.37
1896.	September,	11.8	10.2	.....	12.3	11.3	13.0	3.60	4.32	4.20	3.23
	October,	11.8	10.2	.....	12.3	11.7	12.2	3.60	4.32	4.20	2.62
	November,	11.7	9.9	.....	12.3	11.6	12.0	3.60	4.32	4.34	2.62
	December,	11.7	9.8	.....	12.3	11.1	12.0	3.60	4.32	4.34	2.62
	January,	11.0	9.8	.....	12.3	10.8	11.6	3.60	4.32	4.34	2.62
	February,	10.8	9.8	.....	12.3	10.7	11.3	3.55	3.99	4.13	2.62
	March,	10.8	9.8	.....	12.3	10.7	11.5	3.53	3.87	4.05	2.73
	April,	10.8	9.8	.....	12.3	10.7	11.1	3.60	3.94	4.10	2.73
	May,	10.7	9.9	.....	12.3	10.9	10.8	3.60	3.94	4.10	2.73
	June,	10.5	9.8	.....	12.3	10.8	10.8	3.60	3.94	4.10	2.73
1897.	July,	10.5	9.8	.....	12.6	10.8	10.8	3.60	3.94	4.10	2.73
	August,	10.5	9.8	.....	11.4	10.8	10.7	3.60	3.94	4.10	2.73
	September,	10.2	9.1	.....	9.5	10.8	10.5	3.60	3.94	4.10	2.73
	October,	10.3	9.0	.....	9.5	11.3	10.5	3.60	3.94	4.10	2.73
	November,	11.0	10.1	.....	9.4	11.6	10.8	3.59	3.94	4.10	2.73
	December,	11.2	10.8	.....	9.5	12.1	10.4	3.59	3.94	4.10	2.73
	January,	10.7	10.1	.....	9.4	12.1	11.0	3.59	3.94	4.10	2.73
	February,	10.6	10.0	.....	9.4	11.9	11.0	3.59	3.94	4.10	2.73
	March,	10.5	10.1	.....	9.4	11.9	10.9	3.59	3.94	4.10	2.73
	April,	10.5	9.9	.....	9.4	12.3	10.8	3.60	3.97	4.10	2.68
1898.	May,	10.3	9.7	.....	9.9	11.5	10.7	3.64	4.09	4.10	2.53
	June,	10.1	9.7	.....	9.9	11.0	10.3	3.64	4.09	4.10	2.53
	July,	10.7	10.1	.....	9.9	10.6	10.2	3.64	4.09	4.10	2.53
	August,	11.1	10.5	.....	10.1	10.5	9.7	3.64	4.09	4.10	2.53
	September,	11.8	11.3	.....	11.5	10.5	10.4	3.64	4.09	4.10	2.53
	October,	12.0	11.8	.....	11.7	10.5	10.5	3.64	4.09	4.10	2.53
	November,	11.9	10.3	.....	11.7	10.1	10.9	3.64	4.09	4.10	2.53
	December,	11.7	10.5	.....	11.7	10.3	11.3	3.64	4.09	4.10	2.55
	January,	11.7	10.5	.....	11.7	11.3	11.5	3.64	4.09	4.10	2.53
	February,	11.6	10.4	.....	11.6	10.3	12.4	3.64	4.09	4.10	2.48
	March,	10.0	10.2	.....	11.4	11.1	12.1	3.64	4.09	4.10	2.36
	April,	10.8	10.5	.....	11.5	11.9	11.4	3.64	4.09	4.10	2.36
	May,	10.9	10.6	.....	11.7	17.1	11.5	3.64	4.09	4.10	2.50
	June,	11.1	10.8	.....	11.7	11.5	12.1	3.64	4.09	4.10	2.56
	July,	10.8	10.3	.....	11.7	9.9	12.1	3.64	4.09	4.10	3.13
	August,	10.8	10.5	.....	11.7	9.2	12.3	3.64	4.09	4.10	3.13
	September,	10.8	10.5	.....	11.7	9.1	12.6	3.64	4.09	4.10	3.13
	October,	10.8	10.5	.....	11.7	9.6	12.3	3.64	4.09	4.10	3.13

ON THE PURCHASE OF FERTILIZERS.

BY E. H. JENKINS.

The only rational way to buy fertilizers — or anything else — is for purchasers to *make their own schedule of valuation* immediately before purchasing, thus getting figures which are strictly correct for their special circumstances, and which enable them to compare accurately the different forms of plant food offered to them, with reference to their cost.

To illustrate: In the schedule of "trade values" given on page 17, soluble phosphoric acid is priced at $4\frac{1}{2}$ cents, and reverted phosphoric acid at 4 cents — figures justified by the *average* prices of plain superphosphates for the half-year previous to making the schedule. But by getting quotations from a number of dealers and paying cash, certain farmers have, during the spring of 1898, bought available phosphoric acid in this form for 3.1 cents per pound. On the other hand, others have paid 6.8 cents per pound for it, in form of dissolved bone black.

There is no known difference between the two forms in respect to their value as plant food, and the buyer has paid in the one case more than twice as much for the same quantity of plant food as in the other.

If available phosphoric acid in form of unmixed goods costs 6 cents per pound, it may be cheaper for the buyer to get a factory mixture containing nitrogen, phosphoric acid, and potash. If he can get available phosphoric acid for three cents a pound it may pay him to do his own mixing, or better, perhaps, apply the chemicals unmixed.

The farmer goes into the market to buy plant food in forms which have a suitable mechanical condition and are available to crops, at as low a price as he can.

The mixed fertilizer has no special virtue in it because of its being a mixture. Whether the forms which contain the plant food are mixed before application or not is a circumstance which affects the cost of application or the cost of the ingredients, but does not affect the availability to crops of the plant food itself. Where fertilizers are applied broadcast it

may often be cheaper to apply each raw material separately than to buy them all in a ready-made mixture, or to prepare a mixture on the farm.

No general rule can be given, but the farmers in any community can yearly determine these things for themselves, by jointly securing quotations for mixed fertilizers and fertilizer chemicals from a number of manufacturers *before the spring work begins*, and by buying together.

There is no apparent reason why members of granges or other associations in one neighborhood should not more generally combine and secure from a number of manufacturers bids for a considerable number of tons, or of car lots even, of a fertilizer having a given guaranteed composition, made from certain specified raw materials, with a rebate provided for any failure to meet the guarantee, and at a specified cash price. This practice, which is quite common in other states and which has been adopted to a limited extent in Connecticut, with great advantage to the farmer, deserves more attention by those who prefer to buy mixed goods rather than raw materials.

At present in many of our towns a large number of brands, made by different firms, are sold in small lots to the members of the neighborhood at prices which are from 50 to 100 per cent. above the *cash ton price* of the real plant food contained in them.

If it is granted that this number of fertilizer agents is necessary, that each of the brands sold has a special merit for some particular crop, and if — as is too often the case — the seller must wait six or nine months for his pay, these prices are, perhaps, justified.

It is, however, quite certain that one, two, or three brands, at most, of concentrated mixed fertilizers containing the best forms of plant food — none of them so-called “cheap” fertilizers — would perfectly satisfy the agricultural needs of that community.

It is also certain that if this supply was made by one firm rather than by half a dozen different ones, the work of manufacture and sale could be more cheaply done.

Further, it is certain that if a number of firms made bids for doing the work, a still further reduction of cost to the farmer could be made; and, finally, if purchasers would not call on dealers or manufacturers to do a banking business for them, as well as a fertilizer business, by carrying their notes for three, six, or nine months, the cost of mixed fertilizers to the farmers

of this State would be considerably lessened and the profit of their use correspondingly increased.

The present condition of the trade is illustrated by the following facts:

In one town in this State there are forty farmers, each of whom uses a ton or more of commercial fertilizers, and in the aggregate between 300 to 400 tons are sold. There are eight distinct firms having selling agents there, but the number of brands sold is not known.

In another town there are about seventy farmers who use commercial fertilizers. There are three resident agents, and the goods made by eleven other manufacturers are also sold; the number of brands is considerably larger.

Another correspondent writes: "I know of only one agent in town. He only sells to accommodate his neighbors and to obtain what he uses at somewhere near reasonable cost. He pays cash and waits two years for his pay. He is a fool and he knows it. He is I."

THIRD

REPORT ON FOOD PRODUCTS.

To His Excellency, GEORGE E. LOUNSBURY, Governor of Connecticut:

As required by law, I herewith present the third annual report of this Station on Adulterated Food Products.

Very respectfully yours,

S. W. JOHNSON, *Director.*

THE CONNECTICUT FOOD LAW.

CHAPTER CCXXXV.

PUBLIC ACTS, JANUARY SESSION, 1895.

An Act regulating the Manufacture and Sale of Food Products.

Be it enacted by the Senate and House of Representatives in General Assembly convened:

SECTION 1. It shall be unlawful for any person, persons, or corporation within this State to manufacture for sale, offer, or expose for sale, have in his or their possession for sale, or to sell, any article of food which is adulterated or misbranded within the meaning of this act.

SEC. 2. The term food, as used in this act, shall include every article used for food or drink by man, horses, or cattle. The term misbranded, as used in this act, shall include every article of food and every article which enters into the composition of food, the package or label of which shall bear any statement purporting to name any ingredient or substance as not being contained in such article, which statement shall be untrue in any particular; or any statement purporting to name the substance or substances of which such article is made, which statement shall not give fully the names of all substances contained in such article in any measurable quantity.

SEC. 3. For the purposes of this act, an article shall be deemed adulterated:

First, if any substance or substances be mixed or packed with it so as to reduce or lower or injuriously affect its quality or strength;

Second, if any inferior substance or substances be substituted wholly or in part for the article;

Third, if any valuable constituent of the article has been wholly or in part abstracted;

Fourth, if it be an imitation of or sold under the name of another article;

Fifth, if it is colored, coated, polished, or powdered whereby damage is concealed, or if it is made to appear better or of greater value than it is;

Sixth, if it contains poisonous ingredients which may render such article injurious to the health of a party consuming it, or if it contain any antiseptic or preservative not evident and not known to the purchaser or consumer;

Seventh, if it consists, in whole or in part, of a diseased, filthy, decomposed, or putrid substance, either animal or vegetable, unfit for food, whether manufactured or not, or if it is in any part the product of a diseased animal, or of any animal that has died otherwise than by slaughter;

Provided, that an article of food product shall not be deemed adulterated or misbranded within the meaning of this act in the following cases.

(a) In the case of mixtures or compounds which may be now or from time to time hereafter known as articles of food under their own distinctive names, and not included in definition fourth of this section;

(b) In the case of articles labeled, branded, or tagged, so as plainly or correctly to show that they are mixtures, compounds, combinations, or blends;

(c) When any matter or ingredient is added to a food because the same is required for the protection or preparation thereof as an article of commerce in a fit state for carriage or consumption and not fraudulently to increase the bulk, weight, or measure of the food, or to conceal the inferior quality thereof;

(d) When a food is unavoidably mixed with some extraneous matter in the process of collection or preparation.

SEC. 4. The Connecticut Agricultural Experiment Station shall make analyses of food products on sale in Connecticut suspected of being adulterated, at such times and places and to such extent as it may determine, and may appoint such agent or agents as it deems necessary, who shall have free access, at all reasonable hours, for the purpose of examining into any place wherein it is suspected any article of food adulterated with any deleterious or foreign ingredient or ingredients exists, and such agent or agents upon tendering the market price of said article may take from any person, firm, or corporation samples of any article suspected of being adulterated as aforesaid, and the said station may adopt or fix standards of purity, quality, or strength when such standards are not specified or fixed by statute.

SEC. 5. Whenever said station shall find by its analysis that adul-

terated food products have been on sale in the State, it shall forthwith transmit the facts so found to a grand juror or prosecuting attorney of the town in which said adulterated food product was found.

SEC. 6. The said station shall make an annual report to the governor upon adulterated food products, in addition to the reports required by law, which shall not exceed one hundred and fifty pages, and said report may be included in the report which said station is already authorized by law to make, and such annual reports shall be submitted to the general assembly at its regular session.

SEC. 7. To carry out the provisions of this act, the additional sum of twenty-five hundred dollars is hereby annually appropriated to said Connecticut Agricultural Experiment Station, which sum shall be paid in equal quarterly installments to the treasurer of the board of control of said station, upon the order of the comptroller, who is hereby directed to draw his order for the same.

SEC. 8. Any person who, either by himself, his agent, or attorney, with the intent that the same may be sold as unadulterated, adulterates any food products for man, or horses, or cattle, or, knowing that the same has been adulterated, offers for sale or sells the same as unadulterated, or without disclosing or informing the purchaser that the same has been adulterated, shall be fined not more than five hundred dollars, or imprisoned not more than one year.

SEC. 9. No action shall be maintained in any court in this State on account of any sale or other contract made in violation of this act.

SEC. 10. All acts and parts of acts inconsistent herewith are hereby repealed.

Approved, June 26, 1895.

DUTIES OF THE STATION UNDER THE FOOD LAW.

The fourth, fifth, and sixth sections of the foregoing act lay certain duties upon this Station as follows:

1st. To make analyses of food products suspected of being adulterated.

2d. Whenever it shall find by its analysis that adulterated food products have been on sale, it shall forthwith transmit the facts so found to a prosecuting officer in the town where the adulterated food was found.

3d. The Station shall make an annual report.

The law also provides that the Station may adopt or fix standards of purity, quality, or strength, when such standards are not specified or fixed by statute.

SAMPLES COLLECTED BY THE STATION.

During the year beginning August 1, 1897, authorized agents of this Station visited twenty-eight towns and villages of this State and purchased samples of food products for examination at this Station.

These places were distributed as follows :

	No. of Places.
Litchfield County,	1
Hartford "	4
Windham "	3
Tolland "	0
New London "	4
Middlesex "	2
New Haven "	8
Fairfield "	6
	<hr/>
	28

By this means there have been bought and examined 887 samples of the following names or kinds :

	No. of Samples.
Jelly,	70
Jam,	62
Tea,	89
Coffee,	73
Ginger,	91
Spices in boxes, Pepper,	38
Mustard,	26
Red Pepper,	14
Nutmeg,	6
Cinnamon,	26
Allspice,	21
Cloves,	20
Tapioca, Sago, etc.,	4
Malt liquor,	47
Sausage,	19
Honey,	37
Maple syrup,	3
Milk,	109
Cream,	32
Canned soup,	32
Canned vegetables,	65
Chili sauce,	1
Mince meat,	9
	<hr/>
Total,	894

In studying the chemical composition and microscopical characters of genuine spices from different localities, there have also been analyzed the following number of samples, most of them drawn from original packages in the possession of importers :

	No. of Samples.
Black pepper,	14
Pepper by-products and adulterants,	6
White pepper,	10
Cayenne pepper,	8
Ginger,	18
Ginger by-products, '	3
Cloves,	8
Clove stems,	2
Ceylon cinnamon,	6
Cassia,	23
Cassia buds,	2
Allspice,	3
Nutmegs,	6
Mace,	7
Miscellaneous spice adulterants,	10
Total,	126

It has been our aim to collect as large a number of brands as possible of each of the food products examined, without trying to select the cheaper kinds, which are presumably more likely to be adulterated.

In every case where certain proof of adulteration was found, the facts, as required by the law, have been forthwith transmitted to a grand juror or other prosecuting officer of the town or borough where the adulterated food products were sold.

SAMPLES COLLECTED BY THE STATE DAIRY COMMISSIONER.

The office of Dairy Commissioner was established by an act of the General Assembly, approved April 3, 1886. By this and supplementary acts the commissioner is charged with the enforcement of laws regulating the sale of three articles, viz., butter, vinegar, and molasses.

From the beginning this station has done gratuitously all the chemical work desired by the commissioners, and has given expert testimony in court as required.

During the twelve months covered by this report there have been examined for the present commissioner, Hon. J. B. Noble, two hundred and three samples of molasses, thirty-two samples of vinegar, and seventeen samples of butter and imitation butter, making a total of two hundred and fifty-two.

It thus appears that, exclusive of cattle feeds, the station has examined during the past year twelve hundred and sixty-five samples of food products.

The results appear in detail in the following papers.

JELLIES.

By A. L. WINTON, A. W. OGDEN, AND W. L. MITCHELL.

Pure fruit jelly is a clear, gelatinous product made entirely from the fruit specified and cane sugar. Jellies which are offered for sale containing any other ingredients than these should be distinctly labeled as imitations or compounds in order to meet the requirements of the pure food law.

ADULTERANTS.

These may be classified as follows:

1. *Gelatinous Materials*.—Such as starch paste, gelatine, agar-agar, and apple jelly. Agar-agar is a general name for the gelatinous materials prepared in Japan, India, and other Eastern countries from sea-mosses. Like starch paste, it has little taste or color, and serves merely to stiffen the artificial jellies in which it is used. Apple jelly has a yellow color and a fruity flavor. By the admixture of dye stuffs and flavoring extracts it is readily transformed into counterfeit "currant jelly," "raspberry jelly," etc.

2. *"Sweeteners."*—Glucose or corn syrup is commonly used because of its cheapness. It is much less sweet than cane sugar but is equally harmless. Saccharine, a sweetener prepared by chemical process from coal-tar, is now extensively advertised in the trade journals for use in food preparations. Although it costs about \$15 per pound it can be profitably used in place of cane sugar, since it is about 500 times as sweet. Saccharine has no nutritive properties and in this respect differs from both cane sugar and glucose.

3. *Coloring Matters*.—Coal-tar, or "aniline," dyes (ma-

genta, tropeolin, Bordeaux B, etc.), cochineal, and possibly some vegetable dyes, are used in jellies. Some of the coal-tar colors have been shown to retard, in a marked degree, the process of digestion, and none of them, with our present knowledge, can be regarded as a fit ingredient for food. But, whether injurious or not, dyes serve to make jellies "appear better or of greater value" than they really are and therefore, according to the pure food law, are adulterants.

4. *Fruit Flavors*.—Artificial extracts, or fruit ethers, for flavoring jellies as well as soda water syrups and candies, are prepared by mixing ethers and other chemicals in various proportions. Although these mixtures are claimed to be chemically identical with the true fruit flavors, it usually requires a lively imagination to detect a resemblance, either in taste or odor.

5. *Acids*.—The acidity of jellies prepared from starch paste, agar-agar, and gelatine is secured by the addition of citric, tartaric, or other acids. Apple jelly is of course acid without any such admixture.

6. *Chemical Preservatives*.—Salicylic acid is the common preservative for jellies. Possibly benzoic and sulphurous acids are also used.

EXAMINATION OF SAMPLES OF JELLY FROM THE CONNECTICUT MARKET.

Seventy samples have been examined which may be grouped as follows:

	Sold in bulk.	Sold in labeled packages.	Total.
Jellies not found adulterated,....	—	20	20
Adulterated jellies,	10	33	43
Jellies marked "compound," etc.,	—	7	7
			<hr/> 70

Methods of Examination.

Water. Into a flat-bottomed aluminum dish, 8 cm. in diameter, containing a glass stirring rod, both of which have been weighed together, are brought two grams of the jelly, ten grams of ignited sand and 50 cc. of water. The dish is then placed on the water bath and its contents stirred until the jelly has completely dissolved. The solution is evaporated to dryness, being stirred when the mass begins to stiffen to break up the

lumps and mix the sand. The dish and contents are then heated in a drying cell at 100° C. till the weight is constant.

By this method the drying is completed in nearly every case within fifteen hours, whereas in trials made without sand or without preliminary solution in water the jelly continued to lose in weight appreciably even after drying several days.

Ash is determined by burning below redness.

Nitrogen is determined by the Kjeldahl method.

Polarisation, for the detection of glucose, is done as described on page 158.

Detection of Dyes.—A portion of the jelly is boiled with from one to three parts of water (according to the thickness of the jelly) until the lumps have disappeared. About 25 cc. of this jelly solution are made strongly alkaline with ammonia and shaken for some minutes with colorless amyl alcohol. Another portion is mixed with a few drops of hydrochloric acid and shaken in like manner with amyl alcohol. The clear alcohol layer is separated in both cases and examined for dyes.

If fuchsine is the only dye present the alcohol separated from the alkaline solution is colorless but acquires a magenta color on acidifying with acetic acid, addition of strong hydrochloric acid changes the color to yellow. If no appreciable amount of color is extracted from either the alkaline or the acid solution, further search for dyes is abandoned, but if in either case the alcohol extract is orange or red, or if addition of acetic acid develops a color, dyeing tests with wool are made.

The presence of a coal tar dye should not be affirmed until the color has been fixed on wool and the wool has been washed in boiling water, dried and tested according to the scheme of Witt and Weingaertner.*

In carrying out the dyeing tests the amyl alcohol solution is first evaporated to small volume in the presence of a thread of wool. If this treatment does not fix the color on the wool, water is added and the evaporation repeated. Some coal-tar colors are more readily taken up by wool from an aqueous than an alcoholic solution. The dye extracted from one sample examined did not dye wool at all until the amyl alcohol had been entirely removed by evaporation and the residue had been taken up in water.

A colored amyl alcohol does not prove the presence of a coal-tar color, as we have found that red coloring matters are extracted by this solvent from acid solutions of pure raspberry and grape jellies. These solutions, however, do not dye wool when treated as above described.

When the acid amyl alcohol extract has an orange color and coal-tar dyes are not found, test is made for cochineal by the uranium acetate method.† Cazeneuve's scheme for the detection of dyes‡ and the mercuric acetate methods of testing for acid fuchsine,§ which are so often em-

* Girard et Dupré, *Analyse des Matières Alimentaires et Recherche de leurs Falsification*, pp. 583-593.

† Ibid, p. 580. ‡ Ibid, p. 174. § Ibid, p. 169.

ployed in the examination of wines, are not satisfactory in the case of jellies because filtration is difficult and the reactions often indecisive.

Particulars with regard to the kinds of jelly, the manufacturers, dealers, prices and (in the case of the adulterated and compound jellies) the materials, other than fruit and cane sugar detected, will be found in Tables I, II, and III. The results of the chemical analyses (which are of interest chiefly to food analysts) are given in Table IV.

Most of the pure jellies were made in the household, and all the adulterated samples were factory products. The adulterants detected were, starch paste, other gelatinous matter (probably apple jelly), glucose, magenta and other coal-tar dyes, cochineal and salicylic acid. Artificial fruit ethers were evidently present in many of the samples, but no tests other than taste and smell were applied. Gelatine was not in any case detected.

Some of the spurious jellies contained only one adulterant while in others not less than five adulterants were present.

Samples Nos. 9202 to 9206 inclusive are interesting frauds. Each was put up in a tumbler which was covered with a pasteboard cap labeled: "Pure fruit jellies, W. P. & Co.,* Ayer, Mass." The fruits from which they were supposed to be prepared, as given on other labels were orange, raspberry, strawberry, currant, and grape. These jellies were found to consist of starch paste sweetened with glucose, artificially flavored, colored (in all cases but one) with coal-tar dye and preserved with salicylic acid.

The prices of some of the adulterated jellies should be noted.

Samples Nos. 7898, 7899, 7900, and 9087 sold for 25 cents per jar or pail, containing in each case five pounds of jelly. The pure jellies, on the other hand, cost on the average 25 cents per half pound glass. Disregarding the value of the packages, the four imitations cost only one-tenth as much per pound as the genuine jellies.

* In a monogram. The label on a sample of jam bore the same monogram with the firm name, "Whitcher, Pillman & Co."

TABLE I.—JELLIES NOT FOUND ADULTERATED.

Station No.	BRAND.	DEALER.	Pounds of jelly in glass, jar, or pail.	Price. Cents.
	<i>Apple.</i>			
9245	Superior Apple Jelly, J. A. Thompson & Son, Melrose, Conn.,	<i>Hartford.</i> Wm. C. Smith & Co., 119 Pearl St., . .	5	60
9393	<i>Barberry.</i> Barberry Jelly, Home Made, Mrs. S. C. Stone, New Haven,	<i>New Haven.</i> Gilbert & Thompson, 918 Chapel St., .	$\frac{3}{4}$	35
9387	<i>Crab Apple.</i> Crab Apple Jelly, Home Made, Mrs. S. C. Stone, New Haven,	<i>New Haven.</i> Gilbert & Thompson, 918 Chapel St., .	$\frac{2}{3}$	35
9226	Pure Crab Apple Jelly, F. R. Adams & Co., Boston,	Johnson & Bro., 411 State St.,	$\frac{1}{2}$	25
	<i>Currant.</i>			
9362	Currant Jelly, made at the Station,	<i>Greenwich.</i> Avery & Wilson,	$\frac{2}{3}$	25
9066	Red Currant Jelly, Austin Nichols & Co., N. Y.,	<i>Hartford.</i> H. J. Case & Co., 433 Main St.,	$\frac{1}{2}$	25
9240	Currant Jelly, Francis H. Leggett & Co., N. Y.,			
9389	Currant Jelly, Home Made, Mrs. S. C. Stone, New Haven,	<i>New Haven.</i> Gilbert & Thompson, 918 Chapel St., .	$\frac{2}{3}$	35
9227	Pure Red Currant Jelly, F. R. Adams & Co., Boston,	Johnson & Bro., 411 State St.,	$\frac{1}{2}$	25
9195	Pure Red Currant Jelly, Curtice Bros., Rochester, N. Y.,			
9395	Currant Jelly, Home Made,	Harry Leigh, 354 State St.,	$\frac{1}{2}$	25
9082	Red Currant Jelly, Gordon & Dillworth, N. Y.,	Woman's Exchange, 151 Orange St.,	$\frac{1}{2}$	35
	<i>Grape.</i>	Fitch A. Hoyt, Atlantic Square,	$\frac{1}{2}$	30
9386	Wild Grape Jelly, Home Made, Mrs. S. C. Stone, New Haven,	<i>New Haven.</i> Gilbert & Thompson, 918 Chapel St., .	$\frac{2}{3}$	35

9384	Grape Jelly, Home Made, <i>Pineapple.</i>	. . . . .	<i>New Haven.</i> Woman's Exchange, 151 Orange St.,	$\frac{1}{4}$	25
9388	Pineapple Jelly, Home Made, Mrs. S. C. Stone, New Haven,	. . . . .	<i>New Haven.</i> Gilbert & Thompson, 918 Chapel St.,	$\frac{2}{3}$	35
9390	<i>Plum.</i> Plum Jelly, Home Made, Mrs. S. C. Stone, New Haven,	. . . . .	<i>New Haven.</i> Gilbert & Thompson, 918 Chapel St.,	$\frac{2}{3}$	35
9392	<i>Quince.</i> Quince Jelly, Home Made, Mrs. S. C. Stone, New Haven,	. . . . .	<i>New Haven.</i> Gilbert & Thompson, 918 Chapel St.,	$\frac{2}{3}$	35
9311	Pure Fruit Jellies for Family Use, Quince, Steele Bros., New Britain,	. . . . .	<i>Norwich.</i> Welcome A. Smith, 137 Main St.,	$\frac{1}{4}$	15
9313	Home Made Quince Jelly, R., <i>Raspberry.</i>	. . . . .	A. T. Otis, 261 Main St.,	$\frac{1}{4}$	20
9044	Raspberry Jelly, Home Made, Mrs. S. C. Stone, New Haven,	. . . . .	<i>Bridgeport.</i> R. T. Whiting, 345 Main St.,	$\frac{2}{3}$	35
9391	<i>Strawberry.</i> Strawberry Jelly, Home Made, Mrs. S. C. Stone, New Haven,	. . . . .	<i>New Haven.</i> Gilbert & Thompson, 918 Chapel St.,	$\frac{2}{3}$	35

TABLE II. ADULTERATED JELLIES. (NOT MADE ENTIRELY

Station No.	BRAND.	DEALER.
	<i>Apple.</i>	
9218	Extra Quality Apple Jelly. Made from select fruit,	<i>New Haven.</i> — New Haven Public Market, 390 State St.,
	<i>Crab Apple.</i>	
9237	Superior Crab Apple Jelly, American Preservers Co.,	<i>Hartford.</i> — Barrows & Thalheimer, 525 Main St., . .
	<i>Currant.</i>	
9015	Currant Jelly. Sold in bulk,	<i>Bridgeport.</i> — Centennial Tea Co., 856 Main St., . . .
9023	Economy Currant Jelly, The W. Va. Preserving Co., Wheeling,	Coe & White, 560 Main St.,
9030	Currant Jelly. Sold in bulk,	David O'Donnell, 628 Main St.,
9013	do. do. . . .	John T. Sullivan, 222 E. Main St., . . .
9029	do. do. . . .	R. Wundrack, 575 Main St.,
9248	do. do. . . .	<i>Meriden.</i> —Block & Behrens, 74 E. Main St.,
9338	do. do. . . .	<i>Middletown.</i> —A. M. Bidwell, 344 Main St.,
9340	Excelsior Currant Jelly, New York,	W. K. Spencer, 98 Main St.,
9205	Currant Jelly, Pure Fruit Jellies, W. P. & Co., Ayer, Mass.,	<i>New Haven.</i> —S. S. Adams, 412 State St., . .
9223	Currant Jelly. Sold in bulk,	do. do. . . .
7898	Currant Jelly, The W. Va. Preserving Co., Wheeling,	Coe & Jenks, 422 State St.,
9186	Currant Jelly, Columbia Preserving Co., Boston,	Harry Leigh, 354 State St.,
9216	Extra Quality Currant Jelly. Made from select fruit,	New Haven Public Market, 390 State St.,
9301	Currant Jelly. Sold in bulk,	<i>Norwich.</i> —George Lepau, 252 Franklin St.,
9327	Fine Fruit Jellies, Currant, Oliver Day & Co., Boston,	<i>Putnam.</i> —W. J. Bartlett,
9080	Currant Jelly. Sold in bulk,	<i>Stamford.</i> —Fitch A. Hoyt,
9073	do. do. . . .	T. F. Maher, 7 Pacific St.,
9087	Currant Jelly, Orange Preserving Co., N. Y.,	W. W. Edwards, 99 Main St.,
	<i>Grape.</i>	
9092	Grape Jelly,	<i>Hartford.</i> — J. C. & Co., Hill Grocery, 558 Asylum St.,
9206	Grape Jelly, Pure Fruit Jellies, W. P. & Co., Ayer, Mass.,	<i>New Haven.</i> —S. S. Adams, 412 State St., . .
9185	Grape Jelly, Columbia Preserving Co., Boston,	Harry Leigh, 354 State St.,
	<i>Guava.</i>	
9234	Guava Jelly, E. T. Cowdrey & Co., Boston,	<i>Putnam.</i> — A. C. Stetson,
	<i>Orange.</i>	
9203	Orange, Pure Fruit Jellies, W. P. & Co., Ayer, Mass.,	<i>New Haven.</i> — S. S. Adams, 412 State St.,
	<i>Peach.</i>	
9255	Peach Jelly, Eagle Preserving Co., New York,	<i>Meriden.</i> — L. C. Brown, 4 E. Main St.,
9215	Extra Quality Peach Jelly. Made from select fruit,	<i>New Haven.</i> — New Haven Public Market, 390 State St.,

FROM THE FRUIT SPECIFIED AND CANE SUGAR).

Pounds of jelly in glass, jar, or pail.	Price. Cents.	Gelatinous matter.	Sugar.	Coloring matter.	Preservative.
$\frac{1}{3}$	5	.....	Glucose,		
$\frac{1}{3}$	10	Starch paste,	Glucose,	.....	Salicylic acid.
1	5	Starch paste,	Glucose,	Red coal-tar dye.	
$\frac{1}{2}$	10	.....	Glucose,	.....	Salicylic acid.
1	5	Starch paste,	Glucose,	Magenta.	
1	5	Probably apple,	Glucose,	Red coal-tar dye.	
1	7	Starch paste,	Glucose,	Red coal-tar dye.	
1	5	Starch paste,	Glucose,	Magenta.	
1	10	Starch paste,	Glucose,	Magenta.	
$\frac{1}{2}$	15	Starch paste,	Glucose,	.....	Salicylic acid.
$\frac{1}{2}$	10	Starch paste,	Glucose,	Red coal-tar dye,	Salicylic acid.
1	5	Starch paste,	Glucose,	Magenta.	
5	25	Probably apple,	Glucose,	Magenta.	
$\frac{2}{3}$	10	Probably apple,	Glucose,	Magenta.	
$\frac{1}{3}$	5	Starch paste,	Glucose,	Magenta.	
1	5	Starch paste,	Glucose,	Red coal-tar dye.	
$\frac{2}{3}$	10	.....	Glucose,	Red coal-tar dye.	
1	6	Starch paste,	Glucose,	Red coal-tar dye.	
1	8	Starch paste,	Glucose,	Orange coal-tar dye.	
5	23	Probably apple,	Glucose,		
$\frac{1}{4}$	10	Starch paste,	Glucose,		
$\frac{1}{2}$	10	Starch paste,	Glucose,	Red coal-tar dye,	Salicylic acid.
$\frac{2}{3}$	10	Probably apple,	Glucose,	Magenta.	
$\frac{1}{2}$	20	.....	Glucose,		
$\frac{1}{2}$	10	Starch paste,	Glucose,	Salicylic acid.
$\frac{1}{2}$	10	Starch paste,	Glucose,		
$\frac{1}{3}$	5	Starch paste,	Glucose,		

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TABLE II. ADULTERATED JELLIES. (NOT MADE ENTIRELY

Station No.	BRAND.	DEALER.
	<i>Pineapple.</i>	
9280	Pineapple Jelly, Philip T. Ritter Conserve Co., Phila.,	<i>New London.</i> — Daboll & Freeman, 148 State St.,
9326	Pineapple Jelly, Berry Preserving Co., Boston,	<i>Putnam.</i> — W. H. Mansfield,
	<i>Quince.</i>	
9194	Curtice Pure Quince Jelly, Curtice Brothers, Rochester, N. Y.,	<i>New Haven.</i> — Harry Leigh, 354 State St.,
	<i>Raspberry.</i>	
9022	Raspberry Jelly, The Ayer Preserving Co., Ayer, Mass.,	<i>Bridgeport.</i> — Bridgeport Public Market, 39 Bank St.,
9204	Raspberry Jelly, Pure Fruit Jellies, W. P. & Co., Ayer, Mass.,	<i>New Haven.</i> — S. S. Adams, 412 State St.,
7899	Raspberry Jelly, The W. Va. Preserving Co., Wheeling,	Coe & Jenks, 422 State St.,
9308	Raspberry Jelly,	<i>Norwich.</i> —H. I. Palmer, 231 Main St.,
9070	Crystal Jelly, Raspberry, Extra Quality, New York,	<i>Stamford.</i> — Geo. A. Ferris, 184 Main St.,
	<i>Strawberry.</i>	
9241	Strawberry Jelly,	<i>Hartford.</i> — H. J. Case & Co., 433 Main St.,
9258	Strawberry Jelly, Eagle Preserving Co., 110 Hudson St., N. Y.,	<i>Meriden.</i> — H. F. Rudolf, 14 Pratt St.,
9352	Strawberry Jelly, Pure Fruit Jellies, W. P. & Co., Ayer, Mass.,	<i>Middletown.</i> — G. E. Burr, 136 Main St.,
9202	Strawberry Jelly, Pure Fruit Jellies, W. P. & Co., Ayer, Mass.,	<i>New Haven.</i> — S. S. Adams, 412 State St.,
7900	Strawberry Jelly, The W. Va. Preserving Co., Wheeling,	Coe & Jenks, 422 State St.,
9187	Strawberry Jelly, Columbia Preserving Co., Boston, Mass.,	Harry Leigh, 354 State St.,
9217	Extra Quality, Strawberry Jelly. Made from select fruit,	New Haven Public Market, 390 State St.,
9401	Strawberry Jelly, Whitcher, Pillman & Co., Ayer, Mass.,	N. A. Fullerton, 926 Chapel St.,

TABLE III.

9260	Fine Fruit Jellies, Currant, Compound, American Preserving Co., Phila.,	<i>Meriden.</i> —F. W. Miner, 213 Pratt St.,
9344	Currant Flavor, Pomona Jellies, made from the juice of fruit and refined sugar,	<i>Middletown.</i> —S. T. Camp, 234 Main St., Cottage Market, cor. Main and Washington Streets,
9348	Peach Flavored Jelly, Williams Bros. & Charbonneau, Detroit, Mich.,	<i>Norwich.</i> —T. A. Stoddard, 100 Franklin St.,
9314	Clifford's Fruit Flavor Jellies, Strawberry,	do. do.
9315	Clifford's Fruit Flavor Jellies, Currant,	<i>Putnam.</i> —A. C. Stetson,
9335	Crystal Currant Jelly, Compound,	Edward Mullan,
9321	Currant Flavored Jelly, Williams Bros. & Charbonneau, Detroit, Mich.,	

FROM THE FRUIT SPECIFIED AND CANE SUGAR.)—*Continued.*

Pounds of jelly in glass, jar, or pail.	Price. Cents.	Gelatinous matter.	Sugar.	Coloring matter.	Preservative.
$\frac{2}{3}$	20	.....	Glucose.		
$\frac{2}{3}$	25	.....	Glucose.		
$\frac{1}{2}$	25	Quince,	Cane sugar,	Cochineal.	
5	25	Probably apple,	Glucose,	Red coal-tar dye.	
$\frac{1}{2}$	10	Starch paste,	Glucose,	Red coal-tar dye,	Salicylic acid.
5	25	Probably apple,	Glucose,	Magenta.	
$\frac{1}{2}$	15	Starch paste,	Glucose,	Red coal-tar dye.	
$\frac{1}{2}$	10	Probably apple,	Glucose,	.....	Salicylic acid.
$\frac{1}{2}$	10	.....	Glucose,	Coal-tar dye.	
5	30	Probably apple,	Glucose,		
$\frac{1}{2}$	15	Starch paste,	Glucose,	Red coal-tar dye.	
$\frac{1}{2}$	10	Starch paste,	Glucose,	Red coal-tar dye,	Salicylic acid.
5	25	Probably apple,	Glucose,	Magenta.	
$\frac{2}{3}$	10	Probably apple,	Glucose,	Magenta.	
$\frac{1}{3}$	5	Starch paste,	Glucose,	Magenta.	
$\frac{1}{2}$	10	Probably apple,	Glucose,	Red coal-tar dye,	Salicylic acid.

COMPOUND JELLIES.

$\frac{2}{3}$	10	Starch paste,	Glucose,	Red coal-tar dye,	Salicylic acid.
$\frac{1}{2}$	18	Starch paste,	Cane sugar,	Red coal-tar dye.	
$\frac{1}{2}$	10	Starch paste,	Glucose,		
$\frac{1}{3}$	10	Probably apple,	Glucose,	Orange coal-tar dye.	
$\frac{1}{3}$	10	Starch paste,	Glucose,		
5	30	Probably apple,	Glucose,		
$\frac{2}{3}$	15	Starch paste,	Glucose,		

TABLE IV. ANALYSES OF JELLIES.

Station No.		Water.	Ash.	Nitrogen.	POLARIZATION. SUGAR DEGREES.				
					Direct.		After Inversion.		
					Reading.	Temp. C.	Reading.	Temp. C.	Reading at 86° C.
<i>Jellies not found adulterated.</i>									
9245	Apple,	28.82	0.53	0.05	-34.6	21	-46.4	22	-16.0
9393	Barberry,	35.41	.25	.08	-10.0	25	-21.2	24	0.4
9387	Crab apple,	37.26	.53	.08	19.0	22	-19.0	23	-0.2
9226	"	24.88	.21	.05	39.8	24	-22.0	24	-1.0
9362	Currant,	26.81	.33	.04	-20.0	24	-22.4	22	0.0
9066	"	30.18	.32	.04	-4.5	23	-22.0	21	0.0
9240	"	43.11	.75	.05	-1.6	25	-17.6	24	-0.2
9389	"	37.34	.33	.10	25.0	23	-19.2	23	0.4
9227	"	27.61	.54	.06	-6.7	23	-23.1	22	0.0
9195	"	38.01	.79	.06	-7.6	23	-20.4	25	-0.6
9385	"	34.21	.29	.08	10.0	26	-19.6	25	2.2
9082	"	30.90	.65	.07	-6.6	24	-20.0	24	0.0
9386	Grape,	36.04	.10	.05	27.4	22	-19.6	22	0.6
9384	"	29.20	.44	.07	41.6	23	-22.4	22	1.0
9388	Pineapple,	31.84	.26	.07	35.2	22	-22.0	24	-0.4
9390	Plum,	36.29	.32	.08	24.0	24	-20.0	22	1.0
9392	Quince,	40.46	.16	.05	14.0	25	-18.6	23	-0.4
9311	"	32.15	.12	.04	9.6	26	-19.6	24	0.0
9313	"	34.77	.28	.03	14.4	25	-19.6	23	0.0
9044	Raspberry,	24.38	.47	.11	19.3	21	-25.1	22	-0.1
9391	Strawberry,	36.98	.20	.06	24.6	24	-19.2	24	1.6
<i>Adulterated Jellies.</i>									
9218	Apple,	29.69	.39	.04	64.0	24	44.2	24	51.0
9237	Crab apple,	38.07	.52	.05	106.4	30	103.2	25	98.4
9015	Currant,	32.71	.68	.07	120.6	23	119.2	23	107.6
9023	"	31.62	.62	.05	77.8	26	75.6	23	76.4
9030	"	37.07	.63	.05	106.6	23	103.0	25	
9013	"	39.76	.85	.07	88.2	23	86.6	24	
9029	"	30.76	.82	.05	118.6	22	116.2	23	
9248	"	38.92	.63	.05	107.6	27	105.4	25	102.4
9338	"	40.32	.40	.06	116.2	25	114.2	23	108.2
9340	"	38.78	.52	.04	82.4	25	81.0	25	79.2
9205	"	38.78	.21	.05	104.8	25	93.0	25	91.4
9223	"	37.33	.45	.05	116.4	26	116.4	25	112.4
7898	"	32.63	.72	.05	115.3	22	103.7	21	103.7
9186	"	37.88	.65	.08	66.2	25	64.6	24	69.8
9216	"	38.47	.28	.05	49.8	26	31.8	27	39.4
9301	"	40.50	.70	.06	97.2	26	96.0	24	91.2
9327	"	39.36	.57	.06	85.4	25	67.0	25	71.4
9080	"	38.66	.67	.05	97.4	26	95.4	24	94.4
9073	"	29.70	.72	.05	115.6	24	114.0	23	
9087	"	30.25	.69	.06	123.0	21	120.6	21	
9092	Grape,	35.38	.48	.04	86.4	25	85.4	24	83.8
9206	"	39.38	....	.05	110.0	26	95.6	22	96.0
9185	"	35.16	.54	.05	72.8	25	69.8	23	75.0

TABLE IV. ANALYSES OF JELLIES.—*Continued.*

Station No.		Water.	Ash.	Nitrogen.	POLARIZATION. SUGAR DEGREES.				
					Direct.		After Inversion.		
					Reading.	Temp. C.	Reading.	Temp. C.	Reading at 86° C.
	<i>Adulterated Jellies.—</i>								
	<i>Continued.</i>								
9334	Guava,	17.02	0.49	0.04	78.4	25	30.0	25	44.4
9203	Orange,	37.60	.13	.04	118.4	25	105.4	24	104.4
9255	Peach,	34.97	.50	.05	95.2	27	81.4	25	81.4
9215	"	33.10	.60	.03	58.4	25	41.2	24	59.8
9280	Pineapple,	33.09	.32	.05	68.0	24	35.4	25	42.4
9326	"	33.43	.73	.03	98.8	25	70.2	24	75.4
9194	Quince,	31.68	.34	.03	21.4	22	— 1.2	24	7.0
9022	Raspberry,	36.71	.55	.05	106.0	22	103.2	25	
9204	"	37.94	...	.07	110.0	24	95.2	24	94.4
7899	"	31.37	.73	.05	122.5	23	118.5	23	
9308	"	44.03	.51	.03	96.4	26	94.4	24	90.4
9070	"	30.74	.43	.05	115.4	26	112.6	23	111.4
9241	Strawberry,	38.70	.69	.05	104.2	25	101.6	24	98.4
9258	"	34.12	.57	.05	107.9	21	103.9	26	
9352	"	30.31	.61	.07	99.4	25	88.8	23	91.4
9202	"	36.31	...	.05	107.6	27	94.8	23	94.4
7900	"	32.65	.73	.05	115.7	23	112.8	23	
9187	"	35.15	.75	.07	70.4	25	64.4	24	69.4
9217	"	36.41	.38	.04	57.2	25	29.2	25	38.6
9401	"	38.76	.16	.05	102.0	25	94.0	25	90.0
	<i>Compound Jellies.</i>								
9260	. . . . .	22.79	.34	.05	85.4	25	64.4	25	72.0
9344	. . . . .	24.52	.18	.03	51.2	26	—22.8	24	0.0
9348	. . . . .	37.00	.52	.06	104.6	25	102.4	25	100.4
9314	. . . . .	37.32	.77	.03	53.8	25	52.4	24	58.4
9315	. . . . .	37.53	.50	.03	55.4	27	54.4	25	59.4
9335	. . . . .	30.57	.54	.05	121.1	23	118.7	24	
9321	. . . . .	32.97	.59	.06	115.4	25	114.6	23	110.0

PRESERVES, JAMS, MARMALADES, AND APPLE BUTTER.

By A. L. WINTON, A. W. OGDEN, AND W. L. MITCHELL.

Pure preserves, jams, and marmalades are products obtained by boiling down fruit with enough cane sugar to prevent fermentation. Unlike jellies, they contain the fruit pulp, and in the case of berries, currants, and some stone fruits, the seeds and skins. The presence of any other material than the fruit specified and *cane* sugar should be regarded as an adulteration, except in cases where the package is distinctly labeled so as to show that it is a "mixture, compound, combination, or blend."

Pure apple butter is a sauce made from apples, cane sugar, and spices. It should not contain glucose or chemical preservative.

Adulterants. — The materials mentioned in the chapter on jellies, page 108, are also used in the fruit products here considered. According to Blyth, jams may be readily adulterated with turnip pulp or other cheap vegetable tissue. It is stated that an artificial raspberry jam has been made in this country, in which herds-grass seed took the place of the fruit seeds. We have not, however, been able to detect foreign seeds in any of the samples examined at this station.

EXAMINATION OF SAMPLES FROM THE CONNECTICUT MARKET.

Eleven samples of pure preserves made at this station from fruit and cane sugar, and 51 samples of preserves, jams, marmalades, and apple butter bought by station agents from grocers in various parts of the state, have been examined by the methods described on page 109.

The samples prepared at the station were as follows :

- | | |
|-----------------------------|------------------------------|
| No. 9405. — Blackberry jam. | No. 9397. — Pineapple jam. |
| 9394. — Cherry jam. | 9396. — Plum jam. |
| 9404. — Currant jam. | 9403 and 9364. — Quince jam. |
| 9399. — Orange marmalade. | 9400. — Raspberry jam. |
| 9395. — Peach jam. | 9398. — Strawberry jam. |

The results of the analyses of these samples are given in Table VI, and may serve as standards of composition of pure fruit products.

The samples bought in the Connecticut market may be classified as follows :

Preserves, Jams, and Marmalades :

Not found adulterated,	3
Adulterated (not made entirely from fruit and cane sugar),	44
Labeled "compound,"	2

Apple Butter :

Not found adulterated,	1
Adulterated (not made entirely from apples, cane sugar, and spice),	1

Total,	51
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Preserves, Jams, and Marmalades. — Of the 49 samples bought by station agents, only three were not found to contain other ingredients than fruit and cane sugar. The three were the following :

No. 9010. — Red Currant Jam. Specially prepared for R. C. Williams & Co., New York, by Charles Southwell & Co., London, Eng. Twenty cents per half-pound jar.

No. 9009. — Raspberry Jam. Specially prepared for R. C. Williams & Co., New York, by Charles Southwell & Co., London, Eng. Twenty cents per half-pound jar.

Nos. 9010 and 9009 were bought of George E. Cleaveland, 200 State Street, Bridgeport.

No. 9383. — Strawberry Jam. Home made. Bought at Woman's Exchange, 151 Orange Street, New Haven. Twenty cents per half-pound glass.

All the remaining 46 samples contained glucose ; 27 were preserved with salicylic acid, eight were colored with coal-tar dyes, and four were colored with cochineal. The names of the manufacturers and dealers, the prices paid per jar, and the adulterants detected in the samples not labeled "compound" are given in Table V. The jars, unless otherwise noted, contained from one-half to two-thirds of a pound of the material.

TABLE V.—ADULTERATED PRESERVES, JAMS, AND MARMALADES (NOT MADE ENTIRELY FROM FRUIT AND CANE SUGAR).

Station No.	Brand.	Dealer.	Price per jar or tin, cents.
	<i>Blackberry.</i>		
9032	Campbell's Blackberry Jam, Jos. Campbell Preserve Co., Camden, N. J.,	Bridgeport.—E. L. Sullivan, 436 E. Main st., . .	18
7892	Superior Preserved Blackberries, Max Ams, New York,	New Haven.—D. S. Cooper Co., 470 State st., . .	18
	<i>Cherry.</i>		
9190	Fresh Fruit, Red Cherry Jam, Curtice Bros. Co., Rochester, N. Y.,	New Haven.—Harry Leigh, 354 State st., . .	15
	<i>Currant and Raspberry.</i>		
9243	Currant and Raspberry,	Hartford.—Joseph Hagerty, 75 Front st., . .	10
9189	Fresh Fruit, Raspberry and Currant Jam, Curtice Brothers Co.,	New Haven.—Harry Leigh, 354 State st., . .	15
	<i>Damson.</i>		
9196	Damson Jam, Pure Preserved Fruits, F. P. Adams & Co., Boston,	New Haven.—S. S. Adams, 412 State st., . .	15
9278	Damson Jam, Alexander Cairns, Paisley, Scotland,	New London.—Daboll & Freeman, 148 State st., . .	28
9075	Damson Jam, Crescent Preserve Co., Camden, N. J.,	Stamford.—T. F. Maher, 7 Pacific st., . .	10
	<i>Gooseberry.</i>		
9275	Cairn's Finest Scotch Preserves, Gooseberry Jam, Paisley, Scotland,	New London.—Keefe & Davis, 125 Bank st., . .	20
	<i>Grape.</i>		
7889	Superior Preserved Grapes, Max Ams, New York,	New Haven.—D. S. Cooper Co., 470 State st., . .	18
	<i>Orange.</i>		
9192	Fresh Fruit Orange Marmalade, Curtice Bros. Co., Rochester, N. Y.,	New Haven.—Harry Leigh, 354 State st., . .	15
	<i>Peach.</i>		
9036	Fresh Fruit Jam, Peach, W. H. Clark Co., Rochester, N. Y.,	Bridgeport.—Logan Bros., 863 Main st., . .	15
9014	Peach Jam. Sold in bulk,	J. B. Sullivan, 222 E. Main st., . .	8
9054	Fresh Fruit Peach Jam, Curtice Brothers Co.,	Greenwich.—J. L. Mahoney,	8
7888	Superior Preserved Peaches, Max Ams, New York,	New Haven.—D. S. Cooper Co., 470 State st., . .	18
9289	McMehen's Old Virginia Peach Jam, Wheeling, W. Va.,	New London.—A. E. Foster, 120 Main st., . .	18
9316	Peach Jam, Mrs. Hopkins' Delicious Jams, The E. G. Dailey Co., Detroit, Mich.,	Putnam.—J. E. Sullivan,	20
	<i>Pineapple.</i>		
9198	Grated Pineapple, F. P. Adams & Co., Boston,	New Haven.—S. S. Adams, 412 State st., . .	15
9200	Pineapple Jam, F. P. Adams & Co., Boston,	S. S. Adams, 412 State st., . .	15
7890	Superior Preserved Pineapples, Max Ams, New York,	D. S. Cooper Co., 470 State st., . .	18
9193	Fresh Fruit Pineapple Marmalade, Curtice Bros Co., Rochester, N. Y.,	Harry Leigh, 354 State st., . .	15

TABLE V.—ADULTERATED PRESERVES, JAMS, AND MARMALADES (NOT MADE ENTIRELY FROM FRUIT AND CANE SUGAR).—
Continued.

Station No.	Brand.	Sugar.	Coloring Matter.	Preservative.
	<i>Blackberry.</i>			
9032	Campbell's Blackberry Jam, Jos Campbell Preserve Co., Camden, N. J.,	Glucose	Red coal-tar dye	
7892	Superior Preserved Blackberries, Max Ams, New York,	Glucose	Red coal-tar dye	
	<i>Cherry.</i>			
9190	Fresh Fruit, Red Cherry Jam, Curtice Bros. Co., Rochester, N. Y.,	Glucose	Cochineal	Salicylic acid
	<i>Currant and Raspberry.</i>			
9243	Currant and Raspberry,	Glucose		
9189	Fresh Fruit, Raspberry and Currant Jam, Curtice Brothers Co.,	Glucose		Salicylic acid
	<i>Damson.</i>			
9196	Damson Jam, Pure Preserved Fruits, F. P. Adams & Co., Boston,	Glucose		Salicylic acid
9278	Damson Jam, Alexander Cairns, Paisley, Scotland,	Glucose		
9075	Damson Jam, Crescent Preserve Co., Camden, N. J.,	Glucose		
	<i>Gooseberry.</i>			
9275	Cairn's Finest Scotch Preserves, Gooseberry Jam, Paisley, Scotland,	Glucose		
	<i>Grape.</i>			
7889	Superior Preserved Grapes, Max Ams, New York,	Glucose		
	<i>Orange.</i>			
9192	Fresh Fruit Orange Marmalade, Curtice Bros. Co., Rochester, N. Y.,	Glucose		Salicylic acid
	<i>Peach.</i>			
9036	Fresh Fruit Jam, Peach, W. H. Clark Co., Rochester, N. Y.,	Glucose		
9014	Peach Jam. Sold in bulk.	Glucose		Salicylic acid
9054	Fresh Fruit Peach Jam, Curtice Brothers Co.,	Glucose		Salicylic acid
7888	Superior Preserved Peaches, Max Ams, New York,	Glucose		Salicylic acid
9289	McMeichen's Old Virginia Peach Jam, Wheeling, W. Va.,	Glucose		Salicylic acid
9316	Peach Jam, Mrs Hopkins' Delicious Jams, The E. G. Dailey Co., Detroit, Mich.,	Glucose		
	<i>Pineapple.</i>			
9198	Grated Pineapple, F. P. Adams & Co., Boston,	Glucose		Salicylic acid
9200	Pineapple Jam, F. P. Adams & Co., Boston,	Glucose		Salicylic acid
7890	Superior Preserved Pineapples, Max Ams, New York,	Glucose		Salicylic acid
9193	Fresh Fruit Pineapple Marmalade, Curtice Bros Co., Rochester, N. Y.,	Glucose		Salicylic acid

TABLE V.—ADULTERATED PRESERVES, JAMS, AND MARMALADES (NOT MADE ENTIRELY FROM FRUIT AND CANE SUGAR).—
Continued.

Station No.	Brand.	Dealer.	Price per jar or tin, cents.
<i>Quince.</i>			
9042	Fort Henry Preserves, Quince, The W. Va. Pres'g Co., Wheeling.	Bridgeport.—C. H. Stevens, 398 E. Main st.,	12
9031	Campbell's Quince Jam, Jos. Campbell Preserve Co., Camden, N. J.,	E. L. Sullivan, 436 E. Main st.,	18
7891	Superior Preserved Quinces, Max Ams, New York.	New Haven.—D. S. Cooper Co., 470 State st.,	18
9188	Fresh Fruit Quince Jam, Curtice Bros. Co., Rochester, N. Y.,	Harry Leigh, 354 State st.,	15
<i>Raspberry.</i>			
9263	Raspberries,	Meriden.—C. F. Fox, 90 W. Main st.,	12
9350	Fruit Jams, Raspberry, The E. G. Dailey Co., Detroit, Mich.,	Middletown.—W. F. Mackley, Main st.,	15
9343	Pillman's Pure Preserved Fruits, Wild Raspberry, Whitcher, Pillman & Co., Ayer, Mass.,	J. B. Patterson, 110 Main st.,	15
9197	Wild Raspberries, F. P. Adams & Co., Boston.	S. S. Adams, 412 State st.,	15
7893	Superior Preserved Raspberries, Max Ams, New York.	D. S. Cooper Co., 470 State st.,	18
9224	Thomas Wood's Kentish Farm House Jams, Raspberry, Swanley, Eng.,	Johnson Bros., 411 State st.,	18
9408	Home-made Preserves, Raspberry, H. A. Johnson & Co., Boston.	D. M. Welch & Son, 28 Cong. av.,	50*
9290	Anderson's Raspberry Jam, Anderson Preserving Co., Camden, N. J.,	New London.—A. E. Foster, 120 Main st.,	12
<i>Strawberry.</i>			
9037	Fresh Fruit Jam, Strawberry, W. H. Clark & Co., Rochester, N. Y.,	Bridgeport.—Logan Bros., 863 Main st.,	15
9053	Strawberry Jam, Crescent Preserve Co., Camden, N. J.,	Greenwich.—J. L. Mahoney,	8
9091	Health Brand Jams, Strawberry, Lewis DeGroff & Son, N. Y.,	Hartford.—J. F. Morrissey, 84 Albany ave.,	18
9350	Strawberry, Los Angeles Brand, E. M. Potts & Co.,	Middletown.—D. I. Chapman, 146 Main st.,	25
9190	Wild Raspberries, F. P. Adams & Co., Boston.	New Haven.—S. S. Adams, 412 State st.,	15
9191	Fresh Fruit Strawberry Jam, Curtice Bros. Co., Rochester, N. Y.,	Harry Leigh, 354 State st.,	15
9225	Thomas Wood's Kentish Farm House Jams, Strawberry, Swanley, Eng.,	Johnson Bros., 411 State st.,	18
9270	Strawberry Jam, Batty & Co., London.	New London.—Daboll & Freeman, 148 State st.,	28
9310	Strawberry, Daniels, Cornell & Co., Worcester, Mass.,	Putnam.—J. E. Sullivan,	10
9070	Strawberry Jam, Williams Bros. & Charbonneau, Detroit, Mich.,	Stamford.—Geo. A. Ferris, 184 Main st.,	20
<i>Tomato.</i>			
9355	Fresh Fruit Jam, Tomatoes, Flaccus Bros., Wheeling, W. Va.,	Middletown.—D. I. Chapman, 146 Main st.,	18

* 5 pound jar.

TABLE V.—ADULTERATED PRESERVES, JAMS, AND MARMALADES (NOT MADE ENTIRELY FROM FRUIT AND CANE SUGAR).—
Continued.

Station No.	Brand.	Sugar.	Coloring Matter.	Preservative.
	<i>Quince.</i>			
9042	Fort Henry Preserves, Quince, The W. Va. Pres'g Co., Wheeling.	Glucose	Red coal-tar dye	
9031	Campbell's Quince Jam, Jos. Campbell Preserve Co., Camden, N. J.,	Glucose	.....	Salicylic acid
7801	Superior Preserved Quinces, Max Ams, New York.	Glucose	.....	Salicylic acid
9188	Fresh Fruit Quince Jam, Curtice Bros. Co., Rochester, N. Y.,	Glucose	Cochineal	
	<i>Raspberry.</i>			
9263	Raspberries,	Glucose		
9350	Fruit Jams, Raspberry, The E. G. Dailey Co., Detroit, Mich.,	Glucose		
9343	Pillman's Pure Preserved Fruits, Wild Raspberry, Whitcher, Pillman & Co., Ayer, Mass.,	Glucose	Red coal-tar dye	Salicylic acid
9107	Wild Raspberries, F. P. Adams & Co., Boston,	Glucose	.....	Salicylic acid
7893	Superior Preserved Raspberries, Max Ams, New York,	Glucose	Red coal-tar dye	Salicylic acid
9224	Thomas Wood's Kentish Farm House Jams, Raspberry, Swanley, Eng.,	Glucose		
9408	Home-made Preserves, Raspberry, H. A. Johnson & Co., Boston,	Glucose	Red coal-tar dye	Salicylic acid
9290	Anderson's Raspberry Jam, Anderson Preserving Co., Camden, N. J.,	Glucose		
	<i>Strawberry.</i>			
9037	Fresh Fruit Jam, Strawberry, W. H. Clark & Co., Rochester, N. Y.,	Glucose	.....	Salicylic acid
9053	Strawberry Jam, Crescent Preserve Co., Camden, N. J.,	Glucose	.....	Salicylic acid
9001	Health Brand Jams, Strawberry, Lewis DeGroff & Son, N. Y.,	Glucose	.....	Salicylic acid
9356	Strawberry, Los Angeles Brand, E. M. Potts & Co.,	Glucose	Cochineal	Salicylic acid
9199	Wild Strawberries, F. P. Adams & Co., Boston,	Glucose	.....	Salicylic acid
9191	Fresh Fruit Strawberry Jam, Curtice Bros. Co., Rochester, N. Y.,	Glucose	Cochineal	Salicylic acid
9225	Thomas Wood's Kentish Farm House Jams, Strawberry, Swanley, Eng.,	Glucose		
9279	Strawberry Jam, Batty & Co., London,	Glucose		
9319	Strawberry, Daniels, Cornell & Co., Worcester, Mass.,	Glucose	.....	Salicylic acid
9079	Strawberry Jam, Williams Bros. & Charbonneau, Detroit, Mich.,	Glucose		
	<i>Tomato.</i>			
9355	Fresh Fruit Jam, Tomatoes, Flaccus Bros., Wheeling, W. Va.,	Cane sugar	.....	Salicylic acid

Two pails of preserves made by the Central Preserving Co., 201 State Street, Boston; one (No. 9407) labeled "Raspberry Jam, Compound," the other (No. 9406), "Strawberry Preserve Compound," were bought of D. M. Welch & Son, 28 Congress Avenue, New Haven. Each of the pails contained about five pounds of the preserve, and cost 35 cents.

The following statement of composition was attached to each package :

COMPOUND PRESERVES MADE FROM

Fresh Fruit,	.	.	.	.	.	.	.	.	.250
Corn Syrup,	.	.	.	.	.	.	.	.	.300
Gran. Sugar,	.	.	.	.	.	.	.	.	.250
Fruit Juice,.	.	.	.	.	.	.	.	.	.200
									<hr/>
									1.000

In addition to the materials above mentioned, both samples were found to contain a red coal-tar dye and salicylic acid.

Apple Butter.—Two samples were examined :

No. 9299. Heinz's Apple Butter, H. J. Heinz Co., Pittsburg. Dealer, A. T. Otis, 261 Main Street, Norwich. Price, 25 cts. per 2-pound pail. Contained neither glucose nor salicylic acid.

No. 9300. Apple Butter, West Virginia Preserving Co., Wheeling, W. Va. Dealer, J. A. Stoddard, 100 Franklin St., Norwich. Price, 25 cts. per 2-pound jar. This sample was sweetened with glucose and preserved with salicylic acid.

TABLE VI. ANALYSES OF PRESERVES, JAMS, MARMALADES, AND APPLE BUTTER.

Station No.		Water.	Ash.	Nitro- gen.	POLARIZATION.				
					Direct.		After Inversion.		
					Read- ing.	Temp. c.	Read- ing.*	Temp. c.	Read- ing at 86° c.
	<i>Preserves, Jams, and Marmalades, not found adul- terated.</i>								
9405	Blackberry,	26.41	.60	.19	-4.6	26	-20.0	23	1.0
9394	Cherry,	25.21	.38	.10	4.0	25	-20.0	25	1.2
9404	Currant,	27.38	.45	.20	-6.6	25	-21.8	23	0.8
9010	do	27.15	.50	.12	-16.5	26	-23.3	23	-2.2
9399	Orange,	34.57	.52	.10	4.2	25	-16.2	26	1.0
9395	Peach,	33.73	.41	.06	19.8	26	-19.6	21	0.4
9397	Pineapple,	29.82	.38	.10	21.4	25	-20.4	24	0.5
9396	Plum,*	31.66	.39	.12	6.4	25	-16.2	25	3.0
9403	Quince,	26.85	.23	.05	32.6	26	-21.8	23	0.3
9364	do	17.74	.20	.04	8.2	23	-23.6	23	0.0
9400	Raspberry,	27.99	.33	.15	35.6	25	-19.4	25	0.8
9009	do	26.46	.34	.16	4.8	25	-20.2	24	0.0
9398	Strawberry,	26.50	.65	.18	20.0	22	-22.4	23	-0.2
9383	do	24.90	.73	.16	-15.0	23	-20.0	22	1.4
	<i>Adulterated Preserves, Jams, and Marmalades.</i>								
9032	Blackberry,	30.71	.42	.08	78.0	24	48.0	24	55.0
7892	do	32.50	.59	.11	86.0	25	74.6	24	75.0
9190	Red Cherry,	31.44	.58	.06	38.0	27	19.8	22	31.0
9243	Currant & rasp- berry,	28.05	.58	.06	110.6	26	108.0	24	98.6
9189	do	35.68	.41	.12	40.8	26	20.0	23	31.4
9196	Damson,†	33.91	.50	.10	22.6	26	7.8	25	21.4
9278	do†	31.36	.33	.05	12.8	24	1.0	22	16.0
9075	do	33.70	.62	.08	100.8	24	94.0	25	91.0
9275	Gooseberry,	34.37	.50	.08	21.6	25	8.0	23	21.0
7889	Grape,	31.76	.57	.06	72.8	25	72.0	22	66.8
9192	Orange,	25.12	.27	.05	48.8	25	21.0	23	26.8
9036	Peach,	37.72	.48	.06	61.2	26	28.6	24	37.2
9014	do	30.30	.64	.16	92.5	24	76.1	23	76.1
9054	do	34.91	.38	.07	42.4	23	16.8	22	29.2
7888	do	44.44	.29	.08	43.2	26	9.6	22	21.0

* Pits and skins constituting 0.8 per cent. of the original jam were rejected.

† " " " " 10.6 " " " " " " " " " " 14.7 " " " " " "

TABLE VI. ANALYSES OF PRESERVES, JAMS, MARMALADES, AND APPLE BUTTER.—*Continued.*

Station No.		Water.	Ash.	Nitro- gen.	POLARIZATION.				
					Direct.		After Inversion.		
					Read- ing.	Temp. c.	Read- ing.	Temp. c.	Read- ing at 86° c.
9289	Peach (<i>Cont.</i>),	20.88	.31	.08	60.0	25	47.0	23	57.0
9316	do	31.04	.46	.06	79.2	26	59.0	25	63.6
9198	Pineapple,	23.99	.19	.07	73.4	24	39.4	23	50.0
9200	do	23.89	.20	.06	82.6	25	46.6	22	56.2
7890	do	50.44	.19	.05	36.6	27	12.0	22	20.6
9193	do	31.61	.29	.03	53.2	28	18.0	26	32.0
9042	Quince,	36.94	.63	.04	89.0	24	82.0	24	82.6
9031	do	32.71	.29	.04	74.0	24	43.0	22	50.4
7891	do	41.87	.22	.05	32.4	24	10.4	21	23.0
9188	do	37.92	.36	.05	37.0	26	18.8	24	30.0
9263	Raspberry,	34.43	.50	.07	97.0	27	86.4	25	84.0
9350	do	37.27	.62	.15	68.4	25	62.0	23	65.0
9343	do	24.75	.48	.10	74.8	27	66.6	25	70.0
9197	do	26.01	.38	.09	52.0	26	42.4	25	51.2
7893	do	27.06	.48	.07	89.0	26	77.4	23	80.0
9224	do	26.41	.47	.16	45.6	26	9.6	25	22.8
9408	do	31.90	.58	.10	97.8	26	92.0	23	88.4
9290	do	31.14	.50	.07	14.8	23	7.0	21	22.4
9037	Strawberry,	34.60	.42	.09	50.6	25	36.4	20	45.4
9053	do	25.25	.74	.07	88.4	24	84.0	25	84.0
9091	do	26.21	.67	.08	77.0	27	66.0	22	71.2
9356	do	24.00	.68	.11	57.0	25	18.8	23	33.8
9199	do	26.56	.55	.08	61.2	26	37.8	24	47.0
9191	do	30.05	.41	.09	38.8	25	15.8	23	30.4
9225	do	21.09	.46	.12	60.0	26	20.0	26	35.0
9279	do	22.58	.40	.07	37.8	25	2.6	22	20.0
9319	do	23.91	.57	.09	110.4	25	106.2	24	105.0
9079	do	34.75	.35	.07	64.0	27	56.4	22	60.0
9355	Tomato,	37.18	.53	.18	11.6	26	-19.0	22	0.0
	<i>Compounds.</i>								
9407	Raspberry,	31.12	.24	.10	83.5	26	64.0	23	67.4
9406	Strawberry,	35.68	.71	.06	80.4	26	62.4	25	66.0
9299	Apple Butter,	53.21	.47	.08	-14.0	23	-15.2	23	-1.4
9300	do	49.96	.76	.08	41.0	23	39.2	22	42.0

TEA.

BY A. L. WINTON, A. W. OGDEN, AND W. L. MITCHELL.

Tea is prepared from the leaves of a shrubby plant, *Camellia Thea*, Link, of which there are two quite distinct varieties, considered by some botanists to be separate species. Botanically, the plant is closely related to the camellias of the conservatories.

It is stated that the tea plant has been cultivated in China for at least a thousand years, and in Japan since the beginning of the thirteenth century. It has been introduced into India, Ceylon, Java, Brazil, and some other countries during the present century. China and Japan are still the leading tea producing countries, although teas from India and Ceylon are now coming into extensive use.

Both green and black tea are products of the same plant, the difference in color and flavor being due to the method of preparation. To prepare "green tea" the leaves are dried by artificial heat immediately after picking, thus preserving the chlorophyl, or green coloring matter. When a "black tea" is desired, the leaves are subjected, before drying, to a fermentation, which changes their color to black and develops the characteristic flavor.

The alkaloid of tea, formerly known as "thein," has been shown to be identical with that of coffee, "caffein," and to this principle are attributed the stimulating properties of both beverages.

The imports of tea into the United States for the year ending June 30, 1896, amounted to 93,891,407 pounds, having an import cargo value at 14 cents per pound, of \$12,688,739.61.

ADULTERATION OF TEA.

The foreign materials with which tea has been most often adulterated fall into the following classes :

Mineral Make-Weights.—Such as soapstone, gypsum, iron dust, sand, etc.

Lie Tea.—The trade name of an adulterant consisting of tea dust and other matters made into lumps with starch paste and colored. The lumps go to pieces on treatment with hot water.

Exhausted Leaves.—Tea leaves which have been used for the preparation of the beverage are said to be collected from door to door in China and also in England, and after being dried and restored, as far as possible, to their original appearance are employed for purposes of adulteration.

Foreign Leaves.—Leaves of various plants, as, for example, the beach, willow, elm, rose, wistaria, etc., have frequently been prepared in imitation of tea and mixed with the genuine leaf. This form of adulteration is usually evident to any careful observer, after spreading out the leaves, which have been rendered pliable by treatment with boiling water.

Astringents.—Catechu and some other materials, rich in tannin, were at one time used to give tea artificial strength.

Facing.—Nearly all the green tea and much of the black tea brought into the United States has been “faced” or coated, to impart a gloss and an attractive color. Among the materials employed in facing green tea are Prussian blue, indigo, turmeric, soapstone, and gypsum. Black tea is frequently coated with plumbago or black lead.

As these materials in the quantities employed may not be injurious to health and usually do not perceptibly increase the weight of the tea, it is a disputed question whether they should be regarded as adulterants. Facing is, however, a senseless custom, and when it is generally understood that it increases the cost of production without in any way adding to the value of the tea for the preparation of the beverage, the practice will doubtless be abandoned.

TEA LEGISLATION.

The U. S. Tea Adulteration Act of 1883.—*Battershall states that “the enactment of this law was largely due to the exertions of prominent tea merchants whose business interests were seriously affected by the sale (principally in trade auctions) of the debased or spurious article.”

The law prohibited the importation of tea adulterated with spurious or exhausted leaf, or with so great an admixture of chemicals, or other deleterious substances, as to make it unfit for use. It provided that for each consignment of tea the importer should give a bond to the collector of the port that it

* Food Adulteration and Its Detection, p. 19.

should not be removed from warehouse until released by the custom house officials. Whenever the tea was found, on examination, to come within the prohibitions of the act, the importer was required to give a bond to ship it outside the limits of the country within six months. If this was not done at the expiration of the time specified the tea was destroyed.

As a result of the rigid enforcement of this law, the quality of the tea imported has considerably improved.

The U. S. Act of 1897 to Prevent the Importation of Impure and Unwholesome Tea.—The act of 1883 was repealed in 1897 and a more comprehensive law enacted, which makes it unlawful to import not only adulterated tea, but any that is inferior in purity, quality, or fitness for consumption.

Under this law the secretary of the treasury is required to appoint each year a board of seven tea experts, whose duty it is to fix standards for all the kinds of tea imported and procure samples of standard tea for deposit at the custom houses at New York, Chicago, and San Francisco, and for distribution among tea importers. All tea imported must be compared with these standards by the proper officials, and if found inferior, must be either exported out of the country within six months or destroyed.

Japanese Tea Adulteration Law.—In 1884, the Japanese Government passed a law making it a criminal offense to adulterate tea. Facing is not, however, prohibited as it is claimed that it is justified by the demands of foreign trade.

EXAMINATION OF SAMPLES FROM THE CONNECTICUT MARKET.

During the month of October, 1897, agents of the station purchased, in various parts of the State, 26 samples of green tea, 53 of black tea, and 10 of mixed tea, all of which have been examined. The results of the examinations, with such particulars as could be obtained regarding the kinds of tea, the names and addresses of dealers, and the prices paid per pound, are given in following tables.

METHODS OF EXAMINATION.

Foreign Leaves.—A sample of the tea is boiled with water, and the shape, venation, dentation, and microscopic characters of the moist leaves are noted.

Water is determined by drying two grams to constant weight at 100° C.

Total Ash is determined by incinerating two grams by the usual method.

Ash Insoluble in Water.—The ash prepared as above is boiled with 50 cc. of water and the insoluble portion collected on a Gooch crucible, washed with hot water, dried and ignited.

Ash Soluble in Water is obtained by subtracting the percentage of water-insoluble from the percentage of total ash.

Hot Water Extract.—Two grams of the unground tea are boiled with 200 cc. of water for a half hour, care being taken to replace the water lost by evaporation. The leaves are collected on a tared filter, washed thoroughly with boiling water, dried at 100° C. and weighed.

The sum of the percentages of insoluble leaf and of water, subtracted from 100 per cent., gives the percentage of hot water extract.

The percentages of total and water-insoluble ash show whether or not the tea contains an undue amount of sand or mineral make-weights, and the percentages of hot water extract and water-soluble ash indicate whether or not there is any considerable amount of exhausted leaves. The ocular examination with and without the microscope detects any admixture of foreign leaves.

DISCUSSION OF ANALYSES.

The results of the analyses of tea are given in the table on pages 136 and 137.

The average percentages found in these analyses are as follows:

	No. of Analyses.	Water.	Total Ash.	Water-sol- uble Ash.	Water-insol- uble Ash.	Hot water Extract.
Green tea, .	26	5.18	7.16	3.61	3.54	37.41
Black " .	53	5.94	6.27	3.58	2.69	36.23
Mixed " .	10	6.16	6.72	3.72	3.00	34.35

The range in the percentage amount of ash and of extract, as determined by our analyses, is as follows:

	Green Tea.	Black Tea.
Total Ash,	6.13 to 8.39	5.57 to 7.42
Soluble Ash,	2.80 to 4.01	2.87 to 4.75
Insoluble Ash,	2.25 to 5.59	1.94 to 3.82
Extract,	30.82 to 40.08	28.48 to 44.92

From the analyses of tea made elsewhere and the standard adopted in other countries, it would appear that genuine tea should contain not more than 8 per cent. of total ash nor less than 3 per cent. of soluble ash nor less than 30 per cent. of extract.

Of the samples examined at this Station during the past twelve months, four (all of them green teas) contained more than eight per cent. of ash. This may indicate the presence of some adhering dirt or facing, but in no case was the percentage high enough to show that mineral make-weights had been added.

TABLE VII. TEA NOT FOUND ADULTERATED.

Station No.	Brand.	Dealer.	Price per pound.
7784	Green Tea,	Bridgeport. The Carten Tea Co., 529 Main St.,	\$0.40
7790	"	E. H. Davis, 60 Courtland St.,	.52
7795	"	C. H. Stevens, 398 E. Main St.,	.26
7778	"	Union Pacific Tea Co., 416 Main St.,	.26
9159	"	Danbury. Atlantic & Pacific Tea Co., 163 Main St.,	.28
7773	"	Derby. Grand Union Tea Co., 237 Main St.,	.40
7934	"	Hartford. Grand Union Tea Co., 249 Main St.,	.36
7951	"	Leroy Bros., 691 Main St.,	.40
7932	"	Meriden. Grant's Tea Store, State and Main Sts.,	.30
7930	"	Morton Tea Co., 200 W. Main St.,	.40
9133	"	Middletown. A. B. Atkins, South Farms,	.52
9179	"	Naugatuck. F. K. Grant, 2 Church St.,	.32
7834	"	New Haven. Atlantic & Pac. Tea Co., 386 State St.,	.26
7807	"	Geo. M. Clark, 987 State St.,	.40
7826	"	C. F. Curtiss, 958 State St.,	.36
7918	"	Gilbert & Thompson, 918 Chapel St.,	.80
7912	Young Hyson,	"	1.10
7840	"	N. England Tea Co., 35 Congress Av.,	.30
7845	"	R. M. Stevens, 255	.20
7828	Gunpowder,	Union Pacific Tea Co., 779 Chapel St.,	.26
7973	"	New London. Keefe & Davis, 125 Bank St.,	.26
9120	"	Putnam. Chas. W. Bradway, 80 School St.,	.26
9117	"	J. E. Sullivan, 100 Elm St.,	.26
7764	"	Waterbury. J. A. Edmundson, 415 S. Main St.,	.40
7748	"	E. J. Upson, 841 N. Main St.,	.40
7968	"	Willimantic. H. C. Hall, 17 Union St.,	.32
7765	Black Tea,	Ansonia. G. E. May & Son, High and Maple Sts.,	.28
7768	"	D. M. Welch & Son, 186 Main St.,	.36
7786	"	Bridgeport. Centennial Tea Co., 856 Main St.,	.26
7793	"	J. J. Linehan, 139 Myrtle Ave.,	.26
7780	"	N. England Tea Co., 124 Fairf'd Ave.,	.32
9170	"	Danbury. W. Chambers, 6 West St.,	.40
9162	"	Union Pacific Tea Co., 253 Main St.,	.28
7771	"	Derby. E. J. Malumphy, 40 Elizabeth St.,	.40
7952	"	Hartford. Atlantic & Pacific Tea Co., 427 Main St.,	.40
7937	"	Buckley & Reardon, 169 Main St.,	.52
7944	"	Union Pacific Tea Co., 174 Asylum St.,	.40
7928	"	Meriden. J. Keating & Co., 285 W. Main St.,	.36
9135	"	Middletown. O. H. Cone, 262 Main St.,	.36
9131	"	New England Tea Co., 442 Main St.,	.36
9126	"	W. K. Spencer, 98 Main St.,	.20
9171	"	Naugatuck. The Peoples Grocery, Maple and Main Sts.,	.28
7813	"	Lipton's, New Haven. Geo. J. Burt, 894 State St.,	.50
7856	"	I. B. Chandler, 101 Dixwell Ave.,	.40
7808	"	A. Duhan, 1134 State St.,	.40
7838	"	U. L. Frank Tea Co., 26 Cong. Ave.,	.30
7919	Best Eng. Breakfast,	Gilbert & Thompson, 918 Chapel St.,	1.10
7917	Formosa Oolong,	"	.80
7916	Oolong,	"	.50
7915	Formosa Oolong,	"	1.00

TABLE VII.—CONTINUED. TEA NOT FOUND ADULTERATED.

Station No.	Brand.	Dealer.	Price per pound.
<i>Black Tea—Continued.</i>			
7914	Formosa Oolong.	New Haven. Gilbert & Thompson, 918 Chapel St.,	\$0.70
7913	English Breakfast.	" "	.80
7833	"	Gilson Tea Co., 422 State St.,	.26
7811	"	Geo. Hugo, 1316 State St.,	.36
7848	"	J. C. Kelly, 360 Dixwell Ave.,	.26
7819	"	Kohn Bros., 55 George St.,	.26
7847	Cooper, Cooper & Co.,		
	India and Ceylon,	Malley, Neely & Co., 922 Chapel St.	.50
7816	"	New Haven Grocery Co., 382 State St.,	.40
7817	"	"	
7842	"	Russell Bros., 418 State St.,	.20
7850	Wood's Formosa,	Russian Tea House, 167 Cong. Ave.,	.26
7802	"	H. A. Smith, 7 Shelton Ave.,	.60
7837	"	Jeremiah Sullivan, 114 Nash St.,	.36
7979	"	Edgar Thomas, 859 Chapel St.,	.30
7983	"	J. G. Arnold, 137 Shaw St.,	.40
7981	"	Grand Union Tea Co., 88 State St.,	.40
7997	"	A. M. Stacy, 123 State St.,	.26
9102	"	Norwich. J. D. D. Cranston, 176 W. Main St.,	.38
7991	English Breakfast.	Hong Kong Tea Co., 210 Main St.,	.24
7993	"	J. B. Murphy, 4 W. Main St.,	.40
9121	Formosa Oolong.	Stanton & Tyler, 58 Main St.,	.20
9114	"	Putnam. W. H. Mansfield, 47 Elm St.,	.60
9139	"	Union Pacific Tea Co., 79 Water St.,	.32
9149	"	Stamford. New York Grocery Co., 208 Main St.,	.26
7752	"	B. Polkin, 60 Pacific St.,	.40
7760	Columbia, Russian.	Waterbury. Dillon's Cash Grocery, 45 E. Main St.,	.26
		Waterbury Cheap Grocery, 171 S. Main St.,	.56
7741	"	Waterbury Grocery Co., 165 Bank St.,	.26
7956	"	Willimantic. Grand Union Tea Co., 725 Main St.,	.40
7965	"	Perkins & Blish, 66 Church St.,	.36
7769	Mixed Tea,	Ansonia. Union Pacific Tea Co., 204 Main St.,	.40
9158	"	Danbury. W. W. Edwards, 147 Main St.,	.26
7920	"	Meriden. Fred H. Lewis, 98 W. Main St.,	.36
7854	"	New Haven. Paul L. Baer, 181 Dixwell Ave.,	.30
7814	"	S. S. Adams, Court and State Sts.,	.26
9154	"	S. Norwalk. F. D. Lawton & Co., 22 S. Main St.,	.40
9144	"	Stamford. New Cash Store, 47 Canal St.,	.28
7759	"	Waterbury. W. Dixon & Sanson, 328 Washington Ave.,	.36
7756	"	Jas. F. Phelan, 41 E. Main St.,	.24
7761	"	Willimantic. W. A. Royle, 919 Main St.,	.26

A little less than three per cent. of soluble ash was found in two samples, and a little less than thirty per cent. of extract in four samples, but no one sample was deficient in both soluble ash and extract, and there is, therefore, no clear evidence of the presence of exhausted leaves.

Probably thirty per cent. of extract is too high a standard for all teas, especially as Battershall* states that low grade, but pure, Congou tea may contain as little as twenty-five per cent. Furthermore, some allowance should be made for the method of determination employed — whether the ground or unground leaf is extracted, or whether the extract is weighed or obtained by difference, etc.

In only one sample, No. 9139, were foreign leaves detected, and in that sample the quantity was small and probably due to accident.

The chemical analyses of all the samples gave no evidence of the presence of either mineral make-weights or exhausted leaves.

Nearly all, if not all, the green teas were "faced," but this is not prohibited by the United States law to which reference has been made.

It appears that none of the samples examined has been found adulterated otherwise than by facing. This is especially gratifying when it is considered that the teas examined were, for the most, part, of the cheapest grades.

In 1887, Spencer,† after examining sixty-three samples purchased in Washington, D. C., arrived at the conclusion "that there are few, if any, spurious teas on the market." He further states: "With the strict enforcement of the United States adulteration act the consumer is reasonably well protected so far as securing the genuine leaf is concerned, but, of course, has no protection from the sale of inferior teas."

Now that the law of 1897 is in force, the public has a right to expect that not only the adulterated but also the very inferior teas will be kept out of the country.

* Food Adulteration and Its Detection, p. 25.

† U. S. Dept. Agr. Div. Chem., Bull. 13, p. 898.

TABLE VIII.—ANALYSES OF TEA.

Station No.	Brand.	Water.	Ash.			Hot water extract.
			Total.	Soluble in water.	Insoluble in water.	
7784	<i>Green Tea,</i>	4.81	8.11	3.67	4.47	36.71
7790	"	4.13	7.20	3.62	3.58	39.47
7795	"	6.25	7.66	3.62	4.04	35.32
7778	"	4.94	8.18	3.03	5.15	31.72
9159	"	5.46	6.56	3.56	3.00	38.81
7773	"	5.89	6.72	3.53	3.19	36.55
7934	"	5.46	7.23	3.45	3.78	38.81
7951	"	5.37	6.98	3.75	3.23	39.06
7932	"	4.06	7.62	3.56	4.06	40.00
7930	"	4.21	7.38	3.62	3.76	38.48
9133	"	3.92	6.78	3.63	3.15	39.54
9179	"	5.62	7.09	3.42	2.67	36.34
7834	"	4.99	6.76	3.83	2.93	39.45
7807	"	4.40	6.96	3.76	3.20	37.89
7826	"	4.90	6.77	3.69	3.08	40.08
7918	"	5.80	6.13	3.53	2.60	39.67
7912	"	5.77	6.24	3.99	2.25	39.30
7840	"	3.89	6.96	3.77	3.19	39.34
7845	"	6.24	7.08	3.74	3.34	36.76
7828	"	5.87	8.39	2.80	5.59	30.82
7973	"	6.18	6.19	3.48	2.71	32.83
9120	"	6.82	7.72	3.36	4.36	35.60
9117	"	4.97	7.31	3.48	3.83	35.31
7764	"	4.23	6.97	3.61	3.36	39.65
7748	"	6.00	8.06	4.01	4.05	35.96
7968	"	4.42	7.20	3.79	3.41	39.23
7765	<i>Black Tea,</i>	5.86	6.30	3.59	2.71	34.96
7768	"	4.89	6.32	3.71	2.61	36.05
7786	"	5.64	6.27	3.47	2.80	38.54
7793	"	6.59	5.95	3.50	2.45	41.43
7780	"	6.55	6.77	3.17	3.60	34.47
7771	"	5.57	6.23	3.33	2.90	28.48
9170	"	5.85	6.62	3.53	3.09	36.54
9162	"	6.52	7.42	3.60	3.82	29.90
7952	"	5.32	6.17	3.52	2.65	36.69
7937	"	5.31	6.18	3.66	2.52	37.79
7944	"	6.23	6.35	3.87	2.48	39.11
7928	"	5.48	6.71	3.70	3.01	37.42
9135	"	6.01	6.42	3.51	2.91	36.04
9131	"	6.02	6.12	3.46	2.66	35.96
9126	"	5.89	5.99	3.04	2.95	35.49
9171	"	5.64	6.06	3.49	2.57	40.76
7813	"	6.93	5.68	3.58	2.10	36.62
7856	"	5.74	5.88	3.56	2.32	41.23
7808	"	6.07	6.27	3.53	2.74	38.34
7838	"	5.85	6.86	3.76	3.10	33.21
7919	"	6.85	5.79	3.85	1.94	33.75
7917	"	5.95	6.42	3.64	2.78	37.05

TABLE VIII. — ANALYSES OF TEA. — *Continued.*

Station No.	Brand.	Water.	Ash.			Hot water extract.
			Total.	Soluble in water.	Insoluble in water.	
7916	<i>Black Tea — Continued,</i>	5.41	6.39	3.62	2.77	40.34
7915	"	5.80	5.33	3.48	2.35	42.68
7914	"	5.81	6.14	3.62	2.52	41.17
7913	"	6.92	6.05	3.90	2.15	32.54
7833	"	6.01	5.99	3.36	2.63	33.49
7811	"	6.12	5.75	3.23	2.52	38.94
7848	"	6.32	6.15	3.41	2.74	34.99
7819	"	6.60	6.39	3.75	2.64	31.24
7847	"	6.13	5.63	3.55	2.08	38.10
7816	"	5.18	6.89	3.94	2.95	44.92
7817	"	5.33	6.23	3.10	3.13	35.19
7842	"	6.57	6.63	3.83	2.80	29.43
7850	"	5.52	6.14	3.69	2.45	38.18
7802	"	5.66	6.16	3.55	2.61	39.50
7837	"	6.09	6.14	3.35	2.79	33.39
7979	"	6.40	5.92	3.93	1.99	32.13
7983	"	5.12	7.33	4.75	2.58	34.89
7981	"	6.27	6.61	3.51	3.10	37.32
7997	"	5.51	5.98	3.69	2.29	38.82
9102	"	6.10	6.22	3.03	3.19	34.00
7991	"	6.29	5.67	3.68	1.99	38.82
7993	"	6.01	6.25	3.70	2.55	39.09
9121	"	5.33	5.87	3.62	2.25	39.96
9114	"	6.00	5.99	2.87	3.12	32.92
9139	"	6.06	6.39	3.14	3.25	34.61
9149	"	7.14	6.56	3.73	2.83	31.10
7752	"	5.62	6.83	3.91	2.92	33.40
7760	"	6.51	5.57	3.26	2.31	29.66
7741	"	4.73	6.77	3.43	3.34	36.62
7956	"	5.18	6.32	3.89	2.43	36.66
7965	"	6.54	7.09	4.53	2.56	36.48
7769	<i>Mixed Tea (Green and Black),</i>	5.75	6.66	3.66	3.00	33.98
9158	"	6.14	6.45	3.29	3.16	33.31
7920	"	6.40	6.00	3.62	2.38	35.86
7854	"	5.96	6.65	3.43	3.22	37.18
7814	"	6.45	5.90	3.49	2.41	36.02
9154	"	6.13	6.56	3.48	3.08	36.07
9144	"	6.38	7.15	4.37	2.78	31.23
7759	"	5.81	7.55	4.42	3.13	36.27
7756	"	5.77	6.96	3.63	3.33	31.94
7961	"	6.78	7.31	3.78	3.53	31.67

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COFFEE, COFFEE COMPOUNDS, AND COFFEE SUBSTITUTES.

By A. L. WINTON.

Seventy-three samples were examined, as follows :

		Unground.	Ground.	Total.
Coffee,	{ Not found adulterated,	21	13	34
	{ Adulterated,	2	9	11
Coffee compounds,	. . . . .	2	20	22
Coffee substitutes,	. . . . .	0	6	6
				<hr/> 73

COFFEE.

Descriptions of the samples not found adulterated are given in Table IX and of the adulterated samples in Table X. The proportion of samples found adulterated to the whole number examined during the present year has been much less than during the two preceding years, as shown by the following figures :

PERCENTAGE OF SAMPLES FOUND ADULTERATED.

		Unground.	Ground.	Total.
1896,	. . . . .	25.0	89.2	63.3
1897,	. . . . .	7.7	86.6	57.7
1898,	. . . . .	8.7	40.9	24.4

This improvement is believed to be due to the operation of the pure food law. Mixtures of coffee with peas, chicory, and other materials are still on the market, but they are now sold more generally under distinctive names in labeled packages.

In quoting the statements found on the packages we must not be understood as thereby, in any instance, vouching for their truth.

TABLE IX.—COFFEE NOT FOUND ADULTERATED.

Station No.	BRAND.	DEALER.	Price per $\frac{1}{4}$ pound, cts.
<i>Unground Coffee.</i>			
9160	Sold in bulk,	<i>Danbury.</i> Atlantic & Pac. Tea Co., 163 Main St.,	10
9169	" "	W. Chambers, 6 White St.,	13
9161	" "	Union Pacific Tea Co., 253 Main St.,	9
7946	Mocha & Java Coffee, American Mills, New York,	<i>Hartford.</i> J. C. & Co., 558 Asylum St.,	25*
7935	Sold in bulk,	Grand Union Tea Co., 249 Main St.,	12
7799	" "	<i>Meriden.</i> Centennial Tea Co., 41 E. Main St.,	13
7925	" "	Russell Bros., 2 Colony St.,	13
7927	" "	Pierce & Hupfer, 111 Britannia St.,	13
9136	" "	<i>Middletown.</i> O. H. Cone, 262 Main St.,	13
9130	" "	New Eng. Tea Co., 442 Main St.,	13
9127	" "	W. K. Spencer, 98 Main St.,	10
9174	" "	<i>Naugatuck.</i> Charlie Ark & Co., Maple St.,	14
7832	Old Government Java & Mocha 400 Coffee, Isaac Newton, New York,	<i>New Haven.</i> Gilson Tea Co., 405 State St.,	35*
7985	Sold in bulk,	<i>New London.</i> H. Levin, 38 Bradley St.,	10
7982	" "	A. M. Stacy, 123 State St.,	10
7996	" "	<i>Norwich.</i> W. A. Church, 18 Market St.,	13
9116	" "	<i>Putnam.</i> George Farley, 20 Providence St.,	18
9112	" "	Union Pacific Tea Co., 79 Water St.,	11
9138	Fifth Ave. Mocha & Java, O'Donohue Coffee Co., New York,	<i>Stamford.</i> H. S. Daskam, 59 Atlantic St.,	35*
9140	Sold in bulk,	New York Grocery Co., 208 Main St.,	13
9150	" "	B. Polkin, 60 Pacific St.,	13
<i>Ground Coffee.</i>			
7785	Sold in bulk,	<i>Bridgeport.</i> Centennial Tea Co., 856 Main St.,	10
7777	" "	Union Pacific Tea Co., 416 Main St.,	8
7947	Flag Brand Mocha & Java, W. H. Raymond Grocery Co., Boston,	<i>Hartford.</i> George F. Kellogg, 123 Ann St.,	35*
7986	Crown Royal Mocha & Java, G. W. Whitford, Providence,	<i>New London.</i> T. W. Potter, 72 State St.,	35*
9107	Red Label Java & Mocha, Winslow, Rand & Watson, Boston,	<i>Norwich.</i> A. T. Otis, 261 Main St.,	35*
7815	Sold in bulk,	<i>New Haven.</i> S. S. Adams, 412 State St.,	8
7827	" "	C. F. Curtis, 958 State St.,	13
7839	" "	Unite L. Frank Tea Co., 26 Congress Ave.,	9
7852	" "	C. Kipp, 290 Dixwell Ave.,	13
7843	" "	Russian Tea House, 167 Congress Ave.,	8
7801	Rex Mocha & Java, Lincoln, Seyms & Co., Hartford,	J. Sullivan, 114 Nash St.,	30*
7836	Sold in bulk,	Thomas, 859 Chapel St.,	14
7824	" "	R. Zeidler, 768 Grand Ave.,	13

* Per pound package.

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TABLE X.—ADULTERATED COFFEE.

Station No.	DEALER.	Price per ½ pound, cts.	ADULTERANTS.
	<i>Unground Coffee.</i>		
9145	<i>Stamford.</i> New Cash Store, 47 Canal St., .	11	29% imitation coffee, ¹ 26% peas, 9% chicory.
9142	W. W. Waterbury, 207 Main St., .	11	24% imitation coffee, ¹ 26% peas, 6% chicory.
	<i>Ground Coffee.</i>		
7779	<i>Bridgeport.</i> New England Tea Co., 124 Fairfield Ave., .	13	Peas, chicory, and wheat or rye.
7821	<i>New Haven.</i> Kohn Bros., 55 George St., .	13	Chicory, and wheat or rye.
7841	New England Tea Co., 35 Congress Ave., .	13	Peas, chicory.
7829	Union Pacific Tea Co., 779 Chapel St., .	13	Chicory, and wheat or rye.
7974	<i>New London.</i> J. E. St. John, 265 Bank St., .	13	Hulled peas, chicory.
7751	<i>Waterbury.</i> C. A. Bailey, 834 N. Main St., .	13	Peas, chicory.
7746	H. W. Foote, 447 W. Main St., .	10	Peas, chicory.
7744	New York & China Tea Co., 181 So. Main St., .	13	Chicory, pea-hull pellets. ²
7755	J. F. Phelan, 41 E. Main St., .	13	Chicory, pea-hull pellets. ²

¹ Brown lumps made from wheat middlings to resemble coarsely crushed roasted coffee.² Made of pea hulls and middlings, resembling roasted coffee.

COFFEE COMPOUNDS.

The pure food law provides that a food product shall not be deemed adulterated "in the case of articles labeled, branded, or tagged so as plainly or correctly to show that they are mixtures, compounds, combinations, or blends." It thus appears that a mixture of coffee with other materials, which if sold under the name of coffee would be regarded as adulterated, is a legitimate article of trade when sold in a package bearing a *correct* statement of its character. In labeling such packages, however, various subterfuges are resorted to for the purpose of deceiving the purchaser.

The word "compound" or a statement of composition may appear on the label, but in such small letters or in such an obscure position as to easily escape the notice of the purchaser, or the wording may be such as to convey the impression that the preparation is a compound of coffees rather than of coffee with other materials.

Plates I and II show photographic reproductions of three labels which illustrate these statements.

Some of the preparations described in the following paragraphs were properly labeled, but several instances of deception, if not of violation of the law, may be noted.*

The seven samples named below, representing four brands, contained

Coffee, Peas, and Chicory :

7772, 9123, and 7957. These three samples were purchased at stores of the Grand Union Tea Co., in Derby, Middletown, and Willimantic. In each case the bag was marked at the time of purchase with the words "Royal Compound." The price paid was 13 cents per half pound.

9173. "Boardman & Son's Compound Prime Old Java Coffee, 304 Asylum St., Hartford." "Compound" was in much smaller letters than the rest of the label. Bought of The People's Grocery, Naugatuck. Price, 25 cents per pound package. (See plate I.)

7809. "Imperial Compound Java and Mocha Coffee. Is made from coffees selected especially for their strength, flavor, and superior drinking qualities. Capitol Mills, Hartford, Conn." Bought of Aug. Reisinger, 1267 State St., New Haven. Price, 25 cents per pound can.

7823. "Welcome Coffee Compound. Bryan, Miner & Read, New Haven." Bought of D. M. Welch & Son, 28 Congress Ave., New Haven. Price, 25 cents per pound package; bar of soap given away with the package.

7750. "Good Luck Coffee. O. H. Blanchard, Hartford, Conn. This coffee is compounded from the very best stock, and is as wholesome as the bread we eat. It is double the strength of pure, imported goods, and will make more cups of rich, delicious drink than any other coffees." Bought of E. J. Upson, 841 Main St., Waterbury. Price, 25 cents per pound package; with glass tumbler.

The following sample contained

Coffee, Peas, Chicory, and Wheat or Rye :

7954. "Compound" [stamped on bag]. Bought of J. H. McGuire, 16 Church St., Hartford. Price, 13 cents per half pound.

* For description of other brands, see Rep. 1896, p. 57.

The two following samples were mixtures of

*Coffee, Peas, Chicory, and Imitation Coffee.**

9181. "Red D Prepared Coffee, John C. Turnbull, New York. Red D Prepared Coffee is crushed and packed immediately after roasting, thus preserving the full aroma and flavor, making a rich cup of coffee." Bought of W. F. Brennan, Naugatuck. Price, 25 cents per pound package. Cup and saucer given away with each pound.

7818. "Combination" [stamped on bag]. Bought of Russell Bros., 418 State St., New Haven. Price, 10 cents per half pound.

The following were mixtures of

*Coffee, Peas, Chicory, and Imitation Coffee.**

9180. "Old Reliable Coffee. The Nutmeg Coffee and Spice Mills, Hartford. A compound of delicious drinking coffees and guaranteed to please those who like a full, heavy-bodied cup of Coffee." Bought of W. J. Kelly, Naugatuck. Price, 25 cents per pound can. (See plate I.)

7994. "Stanton's Vegetable Compound Coffee. Stanton & Tyler, Norwich. We do not claim for this wholly the title of coffee, but a compound prepared from fresh, sweet, and nutritious cereals and pure Santos coffee, which is very rich and aromatic." Bought of Stanton & Tyler, Norwich. Price, 20 cents per pound package.

The following brand was composed of

Coffee, Chicory, and Pellets.†

7835. "The Great Atlantic & Pacific Tea Co.'s Granulated 8 o'Clock Breakfast Coffee Mixture. 45% choicest coffee, 30% choicest English chicory, 25% cereals." Bought at their store, 386 State St., New Haven. Price, 13 cents per half pound.

The following brand contained

Coffee, Peas, Chicory, and Pellets:†

7962. "Crown Jewel Java Coffee. Packed by Grand Central Tea Importing Co., New York. Made of pure coffee and cereals." Bought of W. A. Royle, 919 Main St., Willimantic. Price, 22 cents per pound package. (See plate II.)

* Brown lumps, made from wheat middlings to resemble coarsely crushed roasted coffee.

† Made from pea-hulls and middlings.

Crown Jewel Coffee.

DIRECTIONS.
USE ONE TEASPOONFUL TO EACH
CUP OF WATER. DO NOT BOIL THE
COFFEE, BUT USE BOILING WATER,
AND LET IT STAND A FEW MINUTES.
BEFORE STRAINING. WITH CON-
DENSED MILK, OR CREAM, IT WILL
PROVE A DELICIOUS BEVERAGE.

MADE OF PURE COFFEE AND CEREALS



CROWN JEWEL
JAVA COFFEE
PACKED BY
GRAND CENTRAL TEA IMPORTING CO.
NEW YORK.
77-79 HUDSON ST.

OPEN THIS END.

THIS is the
best that has ever been
put up for the money, and
is strongly recommended by
some of the best families
in America for strength,
flavor and economy.

PACKED BY

GRAND CENTRAL TEA CO.,

77-79 Hudson Street, New York.

PLATE II. LABEL ON PACKAGE OF A COFFEE COMPOUND.

OLD RELIABLE
COFFEE
MANUFACTURED BY
Nutmeg Coffee & Spice Mills
HARTFORD, CONN.



ONE POUND, FULL WEIGHT
 A Compound of Delicious Drinking
 Coffees, and guaranteed to PLEASE
 those who like a full Heavy-bodied
 Cup of Coffee.
Put up only in One-Pound Tins

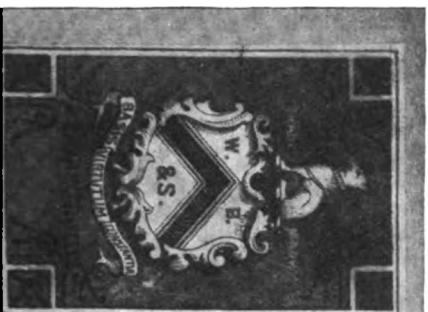


PLATE I. LABELS ON PACKAGES OF COFFEE COMPOUNDS.

The two brands named below are coffees of low grade, roasted and unground, containing a very little sugar:

7831. "Arbuckle's Ariosa Coffee. New York and Pittsburgh. Ariosa is a compound made from coffee, sugar, and eggs. The coffees are selected especially for their strength, flavor, and superior drinking qualities, are pure, sound coffees, and absolutely free from all the poisonous coloring substances which are now so largely used to improve the appearance of coffee. Coffee when roasted is porous, and, unless prevented, loses its best qualities and absorbs others that are injurious to it. By our process of *hermetically sealing* the pores of roasted coffee, we secure a three-fold object: 1st, the retention of the full strength and aroma for any length of time; 2d, the prevention through absorption of any injurious flavors; 3d, the saving to the consumer of the additional expense of eggs incurred when any other coffee is used. ARIOSA is self-settling. Choicest eggs and pure granulated sugar are the only articles used in HERMETICALLY SEALING ARBUCKLE'S ARIOSA COFFEE. Formula: Coffee, .99278; eggs, .00361; sugar, .00361." Bought of Coe & Jenks, 422 State St., New Haven. Price, 15 cents per pound package.

7804. "Lion Fancy Roasted Coffee, Woolson Spice Co., Toledo, Ohio. This package contains only the genuine coffee berry. It is sealed with pure reclarified sugar for the purpose of preserving its strength and purity." Bought of Philip Hugo, 28 Edwards St., New Haven. Price, 15 cents per pound package.

COFFEE SUBSTITUTES.

Various preparations of wheat, rye, barley, peas, etc., containing no real coffee, are sold under special names for those who for any reason prefer them to genuine coffee.

Four such coffee substitutes were examined in 1896, and are described in the report for that year, page 61. The following additional brands were purchased during the month of Oct., 1897:

Two of these consisted of

Whole Barley Kernels, roasted.

7782. "Fischer Mills Fresh Roasted Malt Coffee. B. Fischer & Co., N. Y." Bought of I. P. Prescott, Water and State Sts., Bridgeport. Price, 15 cents per package.

7887. "Kneipp Malt Coffee. Kneipp Malt Food Co., New York and Chicago." Bought at Food Exposition, New Haven, Oct., 1897. Price, 15 cents per package.

The following two samples were prepared from

Roasted Cereals.

7844. "Grain-O. A table beverage which the children may drink without injury as well as the adult. Prepared by the Genesee Pure Food Co., LeRoy, N. Y." Bought of R. M. Stevens, 255 Congress Ave., New Haven. Price, 15 cents per package.

7846. "Postum Cereal, A Toothsome, Healthful Beverage. Postum Cereal Co., Lim. Battle Creek, Mich." Bought of H. M. Tower, 379 Congress Ave., New Haven. Price, 25 cents per package.

The following sample consisted of small brown lumps made from

Pea Hulls with a Paste of Wheat Flour or Middlings.

7933. "Wheat Coffee." Bought of Grant's Tea Store, State and Main Sts., Meriden. Price, 10 cents per pound.

One sample consisted of

Roasted and partially Ground Wheat.

7886. "Old Grist Mill Entire Wheat Coffee. Potter & Wrightington, Agents, Boston." Bought at Food Exposition New Haven, Oct., 1897. Price, 20 cents per package.

(The Old Grist Mill Entire Wheat Coffee examined in 1896 contained not only wheat but also peas and real coffee. See Report, 1896, p. 60.)

GINGER.

By A. L. WINTON AND W. L. MITCHELL.

Ginger is the root or more correctly speaking, the underground stem of a perennial herbaceous plant, *Zingiber officinale*, Rosc., which is cultivated in India, its native country, and also in Jamaica, Cochin China, Africa, and Australia.

Ginger root is used in a "recent" or undried state for the preparation of preserves and confectionery, but most of it is dried in the countries where it is produced and shipped in this form.

Jamaica ginger, which is considered the finest on the market, is scraped before drying to remove the outer coatings, and frequently it is "bleached" or coated with chalk as a protection against the drug-store beetle and other destructive insects. In other countries the root is usually dried without removing the epidermis, although occasionally it is scraped, bleached, or otherwise prepared in imitation of the higher priced Jamaica variety.

At the time when the samples described in this chapter were purchased (Oct., 1897), the following wholesale prices were quoted:

Jamaica, bleached, 19 cents per pound.
 Jamaica, scraped, 18 cents per pound.
 Cochin, $5\frac{1}{4}$ to $7\frac{1}{4}$ cents per pound.
 African, $4\frac{1}{2}$ cents per pound.
 Calcutta, 4 cents per pound.

The unground ginger imported into the United States for the year ending July 30, 1896, amounted to 4,827,703 pounds, and was valued by the custom house officials at 5 cents per pound, making a total wholesale value of \$226,251.56.

Adulteration of Ginger. — Rice middlings, wheat flour, corn meal, mustard husks, turmeric, sawdust, gypsum, and chalk are frequently mixed with ground ginger. Exhausted ginger, the dried residues from the ginger ale and extract factories, is extensively used as an adulterant in England and to some extent in this country.

EXAMINATION OF SAMPLES.

Ninety-one samples purchased by agents of the station have been examined by the methods described on page 186, and may be grouped as follows:

	In labeled packages. In bulk.		Total.
Not found adulterated,	19	48	67
Adulterated,	4	20	24
Total,	23	68	91
Per cent. of samples adulterated,	17.4	29.4	26.4

In Table XI are given the names and addresses of the dealers from whom the samples not found adulterated were purchased, the prices paid, and also, in the case of samples

bought in labeled packages, the names of the brands and of the manufacturers. The adulterated samples are described in like manner in Table XII, and in addition the foreign materials detected in each case are given.

The chemical analyses of the samples will be found in Table XIV.

The adulterant most commonly found in the ground ginger bought in Connecticut was rice middlings, a by-product consisting of the inner seed-coats of the grain with more or less starchy matter. It was present in 20 out of 24 adulterated samples, and in 16 of these it was the only adulterant detected.

Three samples contained gypsum: No. 9235, 19.47 per cent.; No. 7980, 8.35 per cent.; and No. 7747, 8.35 per cent. The other foreign materials detected were wheat middlings, sawdust, corn meal, mustard husks, and turmeric. Samples Nos. 7740 and 7960 contained turmeric, but were believed to be otherwise pure.

Although all the samples were examined by the best approved methods for the detection of exhausted ginger, there was no evidence in any case that this adulterant was present.

TABLE XI. GINGER NOT FOUND ADULTERATED.

Station No.	Brand.	Dealer.	Price per ¼ pound, cents.
66	Sold in bulk,	<i>Ansonia.</i> G. E. May & Son, High and Maple Sts.,	8
14	Pure ginger. Stickney & Poor,	D. M. Welch & Son, Main St.,	10
88	Sold in bulk,	<i>Bridgeport.</i> China & Japan Tea Co., 820 Main St.,	10
89	Slade's Absolutely Pure Ginger.		
	D. & L. Slade Co., Boston, .	E. H. Davis, 60 Courtland St.,	10
75	Genuine Borneo Ginger. Ben-		
	nett, Simpson & Co., London,	Lee & Ketcham, 20 Fairfield Ave.,	10
76	Sold in bulk,	Union Pacific Tea Co., 416 Main St.,	7
96	" " " " " " " "	C. H. Stevens, 398 E. Main St.,	8
68	" " " " " " " "	<i>Danbury.</i> W. C. Chambers, 6 West St.,	10
65	" " " " " " " "	McGraw & Baldwin, 93 White St.,	8
174	" " " " " " " "	<i>Derby.</i> J. McEnerney, 75 Elizabeth St.,	8
186	" " " " " " " "	<i>Hartford.</i> Allen Bros., 132 Main St.,	10
336	" " " " " " " "	Buckley & Reardon, 169 Main St.,	7
194	" " " " " " " "	Cady & Lombard, 69 Albany Ave.,	10
192	" " " " " " " "	Empire Cash Grocery, 94 Albany Ave.,	8
341	Red Shield Ginger. Jas. G.		
	Powers & Co., N. Y.,	Joseph Hagerty, 75 Front St.,	10
110	Pure Jamaica Ginger. Hills &		
	Co.,	Hills & Co., 368 Asylum St.,	10
499	Sold in bulk,	E. M. Palmer, 124 Albany Ave.,	10
489	" " " " " " " "	Chas. A. Post, 709 Main St.,	10
472	" " " " " " " "	C. H. Russell, 383 Main St.,	5
479	" " " " " " " "	A. H. Tillinghast, 91 Main St.,	10
343	Pure Ginger. Union Spice Co.,	Union Pacific Tea Co., 174 Asylum St.,	10
300	Blue Ribbon Pure African Ginger.		
	Austin Nichols & Co., N. Y., .	<i>Meriden.</i> H. E. Bushnell, 79 W. Main St.,	10
931	Sold in bulk,	Grant's Tea Store, State and Main Sts.,	5
929	" " " " " " " "	Morton Tea Co., 200 W. Main St.,	10
926	" " " " " " " "	Pierce & Hupfer, 111 Britannia St.,	10
134	Pure Ginger. E. J. Gillies &		
	Co., N. Y.,	<i>Middletown.</i> O. H. Cone, 262 Main St.,	10
122	Sold in bulk,	Grand Union Tea Co., 272 Main St.,	10
129	" " " " " " " "	N. England Tea Co., 442 Main St.,	10
124	" " " " " " " "	J. B. Patterson, 110 Main St.,	7
178	" " " " " " " "	<i>Naugatuck.</i> F. K. Grant, 2 Church St.,	8
177	Pure Ginger, Capital Mills. Lin-		
	coln, Seyms & Co., Hartford,	The Grant Grocery Co., Maple St.,	10
172	Sold in bulk,	The People's Grocery, Main and Maple Sts.,	10
972	" " " " " " " "	<i>New London.</i> Keefe & Davis, 125 Bank St.,	8
988	" " " " " " " "	Kellogg & Avery, 27 Truman St.,	7
978	Ginger. Wm. Boardman & Son,		
	Hartford,	Albert Peck, Howard St.,	10
976	Sold in bulk,	Thomas & Gumble, 437 Bank St.,	10
1230	Pure Ginger. Equitable Mills.		
	F. R. Farrington & Co., N.	<i>New Haven.</i> S. S. Adams, 412 State St.,	5
	Y. and Boston,	Daniel Dore, 579 Grand Ave.,	5
1737	Sold in bulk,	Mrs. Foley & Co., 763 Grand Ave.,	9
1738	" " " " " " " "	N. A. Fullerton, 926 Chapel St.,	10
1739	" " " " " " " "		

TABLE XI. GINGER NOT FOUND ADULTERATED. — CONTINUED.

Station No.	Brand.	Dealer.	Price per $\frac{1}{4}$ pound, cents.
7730	Pure African Ginger. Howard & Co., N. Y., . . .	<i>New Haven.</i> Mrs. M. L. Gerner, 860 State St.,	10
7729	Sold in bulk, . . .	" " " "	10
7728	Absolutely Pure Ginger. The F. C. Bushnell Co., N. Haven,	Gibbons Bros., 824 State St.,	10
7632	Sold in bulk, . . .	L. Goldbaum, 177 Congress Ave.,	8
7736	" " . . .	N. Haven Prov. Co., 398 Grand Ave.,	8
7461	" " . . .	A. B. Stevens, 61 Broadway,	10
7733	" " . . .	L. C. Strickland, 99 Grand Ave.,	10
7725	Pure Ginger. Crescent Mills, J. P. Auger, New Haven,	Wm. Tansey, 29 Williams St.,	10
7447	Sold in bulk, . . .	H. M. Tower, 379 Congress Ave.,	7
7726	" " . . .	W. E. Waterbury, 774 State St.,	5
7734	Absolutely Pure Ginger. D. M. Welch & Son, . . .	D. M. Welch & Son, 8 Grand Ave.,	8
7454	Sold in bulk, . . .	" " 28 Congress Ave.,	5
7995	" " . . .	<i>Norwich.</i> W. A. Church, 18 Market St.,	10
7990	" " . . .	J. P. Murphy, 4 W. Main St.,	10
9119	" " . . .	<i>Putnam.</i> C. W. Bradway, 80 School St.,	8
9111	Pure Ginger. A. C. Stetson, . . .	A. C. Stetson, Water St.,	10
9113	Sold in bulk, . . .	Union Pacific Tea Co., 79 Water St.,	8
9137	" " . . .	<i>Stamford.</i> H. S. Daskam, 59 Atlantic St.,	8
9156	" " . . .	<i>S. Norwalk.</i> G. E. Friedrich, 20 Railroad Sq.,	8
9153	" " . . .	F. D. Lawton & Co., 22 S. Main St.,	8
9152	" " . . .	C. E. Seymour, 33 Washington St.,	10
7754	" " . . .	<i>Waterbury.</i> Dillon's Cash Store, 45 E. Main St.,	10
7763	Ginger. Helmet XXX Brand. E. R. Durkee & Co., N. Y.,	J. A. Edmundson, 415 S. Main St.,	10
7757	Sold in bulk, . . .	T. P. Kelley, 38 S. Riverside St.,	10
7966	" " . . .	<i>Willimantic.</i> H. C. Hall, 17 Union St.,	10
7969	Pure Ginger. The E. S. Kibbe Co., Hartford, . . .	H. Levins, 493 Main St.,	10
9409	Pure African Ginger. Bugbee & Brownell, Providence, . . .	Burt Thompson, Main St.,	10

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TABLE XII. ADULTERATED GINGER.

Station No.	Brand.	Dealer.	Price per $\frac{1}{4}$ pound, cents.	Adulterated.
7767	Sold in bulk, . . .	<i>Ansonia:</i> D. M. Welch & Son, 186 Main St.,	8	[turmeric. Rice middl'gs, corn meal,
7792	" " . . .	<i>Bridgeport:</i> Peoples Groc. & Prov. Co., 124 Rail'd Av.,	5	Rice middlings, turmeric.
7781	" " . . .	I. P. Prescott, Water and State Sts.,	9	Rice middlings.
9033	Pure Ginger. Wm. A. Leggett & Co., N. Y.,	E. L. Sullivan, 436 E. Main St.,	8	Rice middlings, turmeric.
9157	Sold in bulk, . . .	<i>Danbury:</i> W. W. Edwards, 147 Main St.,	8	Rice middlings.
9235	" " . . .	<i>Hartford:</i> Barrows & Thalheimer, 525 Main St.,	10	[turmeric, 19.47% gypsum.* Sawdust, wheat midd'ngs,
7953	" " . . .	J. H. McGuire, Standard House, 16 Church St.,	10	Rice middlings, turmeric.
7939	" " . . .	M. J. Warren, Sheldon and Front Sts.,	10	Rice middlings, turmeric.
7798	" " . . .	<i>Meriden:</i> Centennial Tea Co., 41 E. Main St.,	8	Rice middlings.
7732	" " . . .	<i>New Haven:</i> C. F. Curtiss, 973 State St.,	10	Rice middlings.
7735	" " . . .	W. S. Graves, 341 Grand Ave.,	10	Rice middlings, mustard husks, turmeric.
7633	" " . . .	P. R. Lyons, 413 Congress Ave.,	8	Rice middlings, turmeric.
7465	" " . . .	John T. Pohlman, 140 Dixwell Ave.,	8	Rice middlings.
7984	" " . . .	<i>New London:</i> H. Levin, 38 Bradley St.,	5	Rice middlings.
7980	Pure Ginger. E. P. Hornick, N. Y.,	A. M. Stacy, 123 State St.,	10	8.35 per cent. gypsum.*
7998	Ginger. The Challenge Mills, N. Y., . . .	<i>Norwich:</i> E. F. Burlingame, 128 W. Main St.,	10	Rice middlings, turmeric.
9104	Sold in bulk, . . .	A. B. Peckham, 147 Franklin St.,	8	Rice middlings.
9115	" " . . .	<i>Putnam:</i> Geo. Farley, 20 Providence St.,	10	Rice middlings.
9143	" " . . .	<i>Stamford:</i> New Cash Store, 47 Canal St.,	5	Rice middlings, turmeric.
9148	" " . . .	B. Polkin, 60 Pacific St.,	6	Wheat, rice middlings.
9147	Ginger. Square Deal Pure Spices, . . .	I. N. Waterbury, 142 Pacific St.,	7	Rice middlings.
7747	Sold in bulk, . . .	<i>Waterbury:</i> Kinney & Balfé, 674 N. Main St.,	10	[cent. of gypsum.* Rice middlings, 8.35 per
7740	" " . . .	Waterbury Grocery Co., 165 Bank St.,	10	Turmeric.
7960	" " . . .	<i>Willimantic:</i> W. A. Royle, 919 Main St.,	8	Turmeric.

* $\text{CaSO}_4 + 2\text{H}_2\text{O}$ calculated from CaO .

DISCUSSION OF THE ANALYSES.

The following maxima and minima results show the range in composition of samples of pure ginger-root and also of pure and adulterated ground ginger found in the market. The analyses of two samples of exhausted ginger are given with these for comparison.

TABLE XIII.—ANALYSES OF GINGER, PURE AND ADULTERATED.
RANGE OF COMPOSITION.

		Ash.			Lime.	Ether extract.		Alcohol extract.	Cold water extract.
		Total.	Soluble in water.	Insoluble in HCl.		Volatile.	Non-volatile.		
Whole Ginger, 13 samples, not coated with chalk.*	Max.	7.55	4.09	2.29	0.71	3.09	5.42	6.58	17.55
	Min.	3.61	2.17	0.05	0.20	1.61	3.37	4.36	12.04
Whole Ginger, 5 samples, coated with chalk.*	Max.	9.35	2.95	1.28	3.53	1.49	4.02	5.37	16.10
	Min.	4.34	1.73	0.02	1.07	0.96	2.82	3.63	10.92
Ground Ginger, 67 samples, not found adulterated.	Max.	9.80	4.10	4.30	0.62	2.37	5.99	7.27	15.72
	Min.	4.32	2.30	.....	.....	0.70	3.02	3.29	11.30
Ground Ginger, 24 samples, adulterated.	Max.	19.26	6.25	3.55	6.34	1.83	8.49	9.88	19.13
	Min.	3.77	1.56	.....	.....	0.26	1.27	3.50	11.06
Exhausted Ginger, No. 9727.*		2.12	0.59	0.18	.....	1.61	3.86	4.88	6.15
Exhausted Ginger, No. 9368.*		5.05	3.55	1.50	.....	0.13	0.54	1.52	16.42

Young† found in 7 samples of pure ginger from 3.40 to 8.00 per cent. of ash and Richardson,‡ in 6 samples, 3.39 to 7.02 per cent. In the analyses of 104 samples, as collated by Allen, the maximum percentage of ash was 10.65.

The Bavarian chemists consider as adulterated all ginger containing over 8 per cent. of ash and 3 per cent. of sand. In the *Codex alimentarius austriacus* it is stated that genuine ginger should not have more than 8 per cent. or less than 1.5 per cent. of ash.

High percentages of ash usually indicate the presence of either sand or of a lime salt. Sand (ash insoluble in HCl) is usually an accidental impurity; sulphate of lime, except when present in small amounts, must, however, be regarded as an adulterant.

"Limed" ginger has been found to contain 1.0 to 3.5 per cent. of lime as carbonate.

Eleven of the samples of ground ginger, containing from 8 to 9.80 per cent. of ash and from 2.50 to 4.30 per cent. of sand, although inexcusably dirty, are classed with those not found adulterated. Samples Nos. 9235, 7980, and 7747 contain not only high percentages of ash, but from 2.72 to 5.55 per cent. of lime as sulphate, and they are without doubt adulterated.

* See page 102.

† Analyst, *Q*, 214.

‡ U. S. Dept. Agr. Div. Chem., Bull., 10, 216.

TABLE XIV. ANALYSES OF GROUND GINGER FROM THE CONN. MARKET.

Station No.		Moisture.	Ash.			Lime (CaO.)	Ether extract.		Alcohol extract.	Cold water extract.
			Total.	Soluble in water.	Insoluble in HCl.		Volatile.	Non-volatile.		
7766	Not found Adulterated.	9.40	7.25	2.82			1.18	3.58	4.83	13.99
9414		9.86	9.17	4.00	3.25	0.32	1.57	3.81	4.87	13.64
7788		9.40	5.89	2.86			1.84	4.53	6.00	13.04
7789		9.54	7.09	3.21			2.01	3.63	5.32	12.78
7775		10.60	4.37	2.56			1.09	4.07	4.91	13.82
7776		8.90	8.00	3.48	2.55	0.60	1.83	3.97	5.49	12.10
7796		9.36	6.50	3.10			1.92	4.15	5.30	12.51
9168		9.58	7.47	3.08			1.24	3.82	5.16	12.81
9165		9.35	4.88	2.52			1.15	3.54	4.99	13.55
7774		9.59	7.17	2.96			0.93	3.60	4.80	11.70
7486		9.11	5.65	3.31			1.52	4.25	5.27	12.60
7936		8.63	7.68	3.06			1.63	4.41	5.17	13.83
7494		9.47	8.25	3.36	2.50	0.46	0.98	3.81	4.96	13.17
7492		8.83	4.89	2.83			1.87	5.62	6.72	13.75
7941		7.79	7.58	3.25			1.88	4.37	5.24	13.50
9410		8.77	4.32	2.84			1.73	5.06	5.28	15.72
7499		9.44	6.05	2.79			1.40	4.44	5.64	11.76
7489		8.45	5.11	2.85			2.06	5.99	7.17	11.30
7472		8.55	5.16	2.92			1.12	3.89	5.68	12.13
7479		8.30	7.95	3.26			1.26	3.45	5.70	13.12
7943		8.67	7.76	3.56			2.06	3.76	4.89	13.55
7800		9.24	6.64	2.76			1.40	4.18	4.77	12.87
7931		9.58	6.31	2.50			1.16	4.68	5.00	12.81
7929		9.21	6.91	3.16			1.72	4.32	5.07	12.58
7926		10.16	7.88	3.51			1.42	3.51	4.65	13.40
9134		9.03	5.07	2.74			2.28	5.17	6.49	13.91
9122		10.08	4.71	2.42			2.03	4.96	6.45	13.19
9129		8.15	5.47	3.03			2.37	4.70	6.44	13.94
9124		9.07	6.84	2.78			1.21	3.88	5.01	12.72
9178		9.08	7.63	3.39			1.18	3.58	5.03	12.07
9177		8.10	7.40	3.38			1.49	4.49	5.88	12.92
9172		9.29	8.47	3.16	3.34	0.32	1.40	4.15	5.43	12.51
7972		8.78	7.29	3.22			2.01	3.56	5.36	13.41
7988		8.81	9.80	3.63	4.30	0.36	1.35	4.04	6.06	13.95
7978		9.69	7.21	3.40			1.31	4.29	5.88	13.23
7976		7.62	7.86	3.64			1.52	4.20	5.43	14.39
9230		8.38	9.54	3.74	4.12	0.54	0.92	3.85	5.10	11.91
7737		9.73	6.33	2.90			1.79	4.10	5.56	12.70
7738		9.68	7.71	3.66			1.35	3.93	4.92	13.19
7739		9.73	8.19	3.44	3.10	0.24	1.74	3.75	5.20	12.42
7730		8.31	6.86	3.26			1.95	5.36	7.27	13.93
7729		9.57	7.96	3.42			1.36	4.01	5.25	12.55
7728		10.42	7.80	2.91			1.01	3.74	4.67	11.70
7632		8.55	7.01	3.53			1.31	3.02	4.27	12.77
7736		8.97	6.95	3.06			1.47	3.88	5.22	13.14
7461		8.31	7.61	3.25			1.03	4.90	3.29	11.06
7733		9.77	6.31	2.76			1.69	3.92	5.48	12.64

TABLE XIV.— CONTINUED.

Station No.		Moisture.	Ash.			Lime (CaO.)	Ether extract.		Alcohol extract.	Cold water extract.
			Total.	Soluble in water.	Insoluble in HCl.		Volatile.	Non-volatile.		
7725	Not found Adulterated.	9.91	7.88	4.10			2.05	5.12	5.87	14.92
7447		9.21	8.39	3.45	3.18	0.60	0.70	4.08	5.58	12.39
7726		9.78	5.19	2.30			1.48	4.49	5.66	12.84
7734		9.52	7.16	2.95			1.61	3.87	5.42	11.58
7454		8.41	7.02	3.01			1.03	3.64	5.18	13.93
7995		9.73	5.34	2.98			1.00	3.24	4.45	13.27
7990		9.82	7.33	3.24			1.25	4.03	5.28	12.51
9119		8.93	8.89	3.26	3.41	0.32	1.53	3.93	5.38	12.73
9111		9.44	7.01	2.53			1.53	4.36	6.35	12.32
9113		9.50	7.14	3.10			1.65	4.16	5.56	12.88
9137		8.68	4.67	2.51			1.78	4.76	5.90	13.43
9156		8.21	7.71	3.63			1.16	3.88	5.74	12.20
9153		9.04	5.98	2.73			1.60	4.56	5.79	12.84
9152		9.29	5.81	3.53			1.59	3.89	5.45	13.60
7754		8.75	5.83	2.99			2.22	4.64	5.98	14.00
7763		9.14	7.75	3.49			1.80	4.47	5.77	11.60
7757		9.33	8.25	3.58	2.59	0.62	1.25	3.75	4.89	12.58
7966		8.61	9.24	3.24	3.64	0.44	1.89	3.43	5.11	12.14
7969		9.55	4.83	2.64			1.70	4.03	5.42	12.66
9409		9.05	5.82	3.01			1.22	3.37	6.84	
7767	Adulterated.	8.87	4.58	2.22			1.03	6.49	7.71	11.62
7792		9.31	7.18	2.98			1.37	4.80	6.37	13.10
7781		9.01	5.55	3.17			1.54	5.11	5.95	13.06
9033		7.88	5.82	2.85			1.61	4.35	6.26	11.30
9157		9.15	5.59	2.19			1.67	4.51	6.08	12.34
9235		8.55	19.26	5.57	1.27	*6.34	1.46	3.70	6.28	19.13
7953		8.53	5.85	2.38			1.15	4.15	5.47	11.53
7939		7.29	7.82	2.99	3.09	0.42	1.83	6.47	9.40	14.02
7798		7.00	10.23	3.21	2.92	0.64	1.32	8.49	9.88	18.41
7732		9.45	5.63	2.18			0.76	3.54	5.08	12.23
7735		7.84	5.77	2.26			1.24	4.02	5.71	13.04
7633		8.31	5.55	2.34			1.59	5.97	7.78	15.00
7465		8.12	5.61	2.18			1.39	6.56	8.43	15.42
7984		10.09	5.16	2.41			0.50	5.51	7.35	14.68
7980		9.11	10.37	6.25	.64	†2.72	1.33	4.44	5.67	16.09
7998		8.55	8.00	3.09	2.57	0.16	0.31	6.92	9.25	15.02
9104		8.82	5.19	2.15			1.80	6.44	8.21	12.34
9115		8.54	6.82	2.41			0.56	7.13	9.11	14.42
9143		9.31	7.62	2.48			0.61	3.28	4.65	11.06
9148		8.79	3.77	1.56			0.26	1.27	3.50	20.18
9147		8.58	9.35	4.12	3.55	0.36	0.98	4.15	5.18	12.88
7747		9.47	12.31	6.07	1.98	†2.72	1.69	3.61	5.42	15.89
7740		9.13	4.70	2.77			1.35	3.46	4.68	13.53
7960		9.50	6.78	2.95			1.41	3.71	5.79	12.79

* SO₃ 9.25.† SO₃ 3.60.‡ SO₃ 3.56.

SALICYLIC ACID IN MALT LIQUORS.

BY A. L. WINTON.

Forty samples of lager beer and seven of ale, all of which were purchased in New Haven, have been tested for salicylic acid.

The results may be summarized as follows :

	In Labeled Bottles.	In Rubber Stoppered Bottles, Not Labeled.	Drawn from the Wood.	Total.
Lager Beer —				
Salicylic acid, not found,	19	8	2	29
Salicylic acid, found,	3	8	0	11
Total,				40
Ale —				
Salicylic acid, not found,	3	1	2	6
Salicylic acid, found,	0	1	0	1
Total,				7

The method used for detecting salicylic acid was as follows :

Method of Testing for Salicylic Acid.—Twenty-five to fifty cc. of the liquor to be tested are acidified with sulphuric acid and the mixture thoroughly shaken in a tube of suitable size with an equal bulk of ether. The ethereal solution is carefully decanted into a flat porcelain dish and the ether evaporated at a gentle heat. The residue is dissolved in absolute alcohol and tested with ferric chloride solution.

Descriptions of the samples of beer and ale not found to contain salicylic acid are given in Tables XV and XVI, and of those found to contain this preservative in Table XVII.

The sample of ale found to contain salicylic acid was bought of W. J. Boettger, 215 Shelton Avenue, and was stated by the dealer to have been brewed by Feigenspan.

TABLE XV. LAGER BEER NOT FOUND TO CONTAIN SALICYLIC ACID.

Station No.	Brand.	Dealer.
<i>In Labeled Bottles.</i>		
7690	Rochester Brewing Co.'s Bohemian,	Free & Waag, 725 State St.
7691	Rochester Brewing Co.'s Premier,	Free & Waag, 725 State St.
7692	Rochester Brewing Co.'s Standard,	Free & Waag, 725 State St.
7693	Rochester Brewing Co.'s Extra Dark Bavarian,	Free & Waag, 725 State St.
7586	Gabriel Sedlmayr München, Versandt Bier,	Edw. E. Hall & Son, 770 Chapel St.
7591	The Bergner & Engel Co., Phila., Tannhaeuser Bier,	Edw. E. Hall & Son, 770 Chapel St.
7590	Beadleston & Woerz, Imperial German Brew,	Edw. E. Hall & Son, 770 Chapel St.
7588	Beadleston & Woerz, Imperial Beer, Gold Label,	Edw. E. Hall & Son, 770 Chapel St.
7589	Rochester Brewing Co., Extra Dark Bavarian,	Edw. E. Hall & Son, 770 Chapel St.
7587	Jos. Schlitz Brewing Co., Celebrated Milwaukee Beer,	Edw. E. Hall & Son, 770 Chapel St.
7594	Pabst Bohemian, Milwaukee,	Edw. E. Hall & Son, 770 Chapel St.
7593	Bürgerbräu, Würzburg, Bavaria (Dark),	Edw. E. Hall & Son, 770 Chapel St.
7596	Brauerei zum Augustiner, München,	W. H. Jensen, 47 Church St.
7685	Jos. Schlitz Brewing Co.'s Celebrated Milwaukee Lager Beer,	Hugh J. Reynolds, 152 Crown St.
7686	Jos. Schlitz Brewing Co.'s Extra Pale Milwaukee Beer,	Hugh J. Reynolds, 152 Crown St.
7687	Jos. Schlitz Brewing Co.'s Münchener,	Hugh J. Reynolds, 152 Crown St.
7600	Pschorr-Bräu, München,	Hugh J. Reynolds, 152 Crown St.
7688	Aktien-Brauerei zum Löwenbräu München, Export Bier,	Chas. Scholl, 156 Crown St.
7703	Chr. Feigenspan's Export Beer, Newark,	C. Shanley, 245 Congress Ave.
<i>In Rubber Stoppered Bottles, Not Labeled.*</i>		
7689	J. Ruppert's,*	J. P. Baldwin, 450 State St.
7705	Ulmer,*	W. J. Boettger, 215 Shelton Ave.
7704	The Springfield Brewing Co.,*	J. P. Carney, 169 Meadow St.
7702	Weibel's,*	Jos. Fappiano.
7697	Weidemann's,*	Fontaine & Heidrich, 231 Cong Av.
7599	Toledo,*	W. Ihne, 66 Crown St.
7716	Quinnipiac,*	Quinnipiac Brewing Co.
7709	F. & M. Schaefer, N. Y., Culmbacher,*	Geo. Stalze, 905 State St.
<i>Drawn from the Wood.</i>		
7717	Narragansett,*	W. Scanlon, 142 Ashmun St.
7723	Rochester,*	J. P. Donnelly, 174 Ashmun St.

* The brand or maker's name was given by the dealer.

TABLE XVI. ALE NOT FOUND TO CONTAIN SALICYLIC ACID.

Station No.	Brand.	Dealer.
	<i>In Labeled Bottles.</i>	
7707	Bass & Co.'s White Label,	John C. Doody, 239 Water St.
7696	Bass & Co.'s Pale Ale,	Wm. Henchy, 254 Congress Ave.
7715	Quinnipiac Brewing Co., Pale Ale,	Quinnipiac Brewing Co.
	<i>In Rubber Stoppered Bottles, Not Labeled.</i>	
7714	Quinnipiac Brewing Co., Still Ale,*	Quinnipiac Brewing Co.
	<i>Drawn from the Wood.</i>	
7713	Ballentine's Ale, Newark,*	Patrick Lee, 166 Ashmun St.
7712	H. Clausen & Son Ale, New York,*	R. E. Wartmann, 134 Starr St.

* As stated by the dealer.

TABLE XVII. BEER FOUND TO CONTAIN SALICYLIC ACID.

Station No.	Brand.	Dealer.
	<i>In Labeled Bottles.</i>	
7694	Rochester Brewing Co., Rienzi,	Free & Waag, 725 State St.
7598	Springfield, Mass., Brewing Co., Gold Medal	
	Tivoli,	Gilbert & Thompson, 918 Chapel St.
7592	Rochester Export Lager Bier,	Edw. E. Hall & Son, 770 Chapel St.
	<i>In Rubber Stoppered Bottles, Not Labeled.</i>	
7701	Fresenius Standard Lager Beer,*	Thos. A. Kean, 285 Water St.
7698	Fresenius Lager Beer,*	Jos. A. Miller, 404 Congress Ave.
7595	Narragansett Lager Beer,*	Chas. Scholl, 156 Crown St.
7700	Feigenspan's Lager Beer,*	Otto A. Scholz, 45 Bristol St.
7711	Liebmann's Lager Beer,*	Geo. W. Shea, 143 Newhall St.
7708	F. & M. Schaefer, N. Y., Wiener Beer,*	Geo. Stelzle, 908 State St.
7710	F. & M. Schaefer, N. Y., Lager Beer,*	Geo. Stelzle, 908 State St.
7699	Bachmann's Lager Beer,*	Aug Wilhelm, 88 Ashmun St.

* Statement of dealer.

SAUSAGE.

BY A. L. WINTON AND W. L. MITCHELL.

In the report for 1897, page 41, will be found descriptions of forty-two samples of sausage purchased during the months of October, November, and December, 1896. Twenty-seven of these samples were found to contain borax.

Nineteen samples, purchased December 8 to 17, 1897, have been examined, not only for borax but also for starch, the principal ingredient of various preparations of Indian corn, potatoes, and wheat, which are used in sausage as absorbents. As it is said that these starchy materials serve not merely to absorb the juices of the meat but also water, which is added as a "filling," the percentage of water in each sample was determined. (See Table XVIII.)

Fourteen of the samples contained borax and ten of them starch, which, in eight cases, was derived from Indian corn, in one from both Indian corn and potatoes, and in one from wheat. The average percentage of water in the samples containing starchy material was 42.40, in the other samples 40.13. This difference is too small to fully warrant the conclusion that the starchy material had been added for the purpose of holding water as a make-weight.

TABLE XVIII. SAUSAGE.

Station No.	Brand.	Dealer.	Price per Pound, Cts.	Preservative.	Water.	Starch.
<i>Bridgeport:</i>						
9018	World's Food Fair Bag Sausage, North Pack. & Prov. Co., Boston.	Bridgeport Pub. Market, 39 Bank St.,	12 ½	Borax	40.70	.....
9019	Peerless P'k Sausage, Jersey City,*	Bridgeport Pub. Market, 39 Bank St.,	12	Borax	44.07	Corn
9021	Plumb & Winton Co.'s Sausage,*	B. Liebscher, 652 Main St.,	10	.....	34.95	.....
9020	Sperry & Barnes' Sausage,*	Village Market, Main St.,	10	Borax	43.77	Corn
<i>Greenwich:</i>						
9234	Made by dealer,*	H. B. Marshall & Co.,	14	.....	41.46	.....
<i>Hartford:</i>						
9089	Hunt's Sausage Meat, A. C. Hunt & Co., Springfield, Mass.,	City Market, 487 Main St.,	10	Borax	36.42	Corn
9088	Springfield Sausage,*	A. C. Hart & Co., Albany Ave.,	10	Borax	37.88	Corn
<i>Meriden:</i>						
9246	Meriden Provision Co.'s Home Made Sausage,	A. W. Gardner, 43 E. Main Str.,	10	Borax	44.41	.....
9247	Made by dealer,*	C. F. Fox, 90 W. Main St.,	12	Borax	48.68	Corn & potato
<i>Middletown:</i>						
9270	Sperry & Barnes' Sausage,*	Bacon & Co., 480 Main St.,	10	.....	31.41	Wheat
9269	Made by dealer,*	Wm. Jamieson, 290 Main St.,	10	.....	36.64	.....
<i>New Haven:</i>						
9213	Armour's Sausage,*	N. Haven Pub. Market, 390 State St.,	8	Borax	42.88	.....
9210	Boston Sausage,*	N. Haven Pub. Market, 390 State St.,	9	Borax	45.84	Corn
9214	Handy's Sausage,*	N. Haven Pub. Market, 390 State St.,	10	Borax	43.74	Corn
9212	Merwin's Sausage,*	N. Haven Pub. Market, 390 State St.,	10	Borax	39.38	.....
9211	Peerless Sausage,*	N. Haven Pub. Market, 390 State St.,	12	Borax	47.50	Corn
<i>New London:</i>						
9266	The G. H. Hammond Co.'s Coin Special Breakfast Sausage.	Market, 20 Main St.,	12	Borax	45.73	Corn
9268	Small Sausage, North Star Brand,	Market, 46 Main St.,	15	Borax	44.51	.....
<i>Norwich:</i>						
9267	Made by dealer,*	Gardner & Reynolds, 4 Market St.,	10	.....	36.39	.....

* Statement of dealer.

EXAMINATION OF HONEY.

BY A. W. OGDEN.

Thirty-seven samples of strained honey have been examined. Of these, five are probably pure; twenty-two may be genuine, though they seem to be made by bees fed somewhat with cane sugar, or to have had invert sugar added to them; two unquestionably contain cane sugar added as an adulterant, and *eight* are adulterated with glucose syrup.

The details regarding these samples appear in Tables XIX and XX.

METHOD OF ANALYSIS. — One-half the normal quantity for polariscopic test* is dissolved in water and clarified when necessary with 1^{cc} each of alum cream and basic lead acetate solution. After making up the volume to 100^{cc} and filtering, the solution is polarized in a 200^{mm} tube. 50^{cc} of the solution are treated with 5^{cc} of strong hydrochloric acid, heated at 68° to 70° C. for ten minutes and polarized a second time, after inversion.

The results in the table are calculated in all cases to the normal quantity.

TABLE XIX. —

Station No.	Label.	Manufacturer or Producer.
<i>Probably Pure.</i>		
9046	Choice Honey,	C. A. Stanton, Newington, Conn.
9067	One Pound Pure Honey,	Said to be native.
9063	Pure Extracted Honey. From the apiary of	W. E. Close, Stanwich, Conn.
9345	Pure Extracted Honey. From the apiary of	Geo. J. Francis, Durham, Conn.
9068	2 lbs. Pure Machine Extracted Honey. From the apiary of	Irving M. June, Riverbank, Conn.
<i>Possibly from Bees fed with Sugar, or with Invert Sugar added.</i>		
9025	Pure Honey,	Wm. T. Gregory, Cranbury, Conn.
9035	Strained Honey,	F. H. Leggett & Co., New York.
9041	Pure White Clover Honey,	W. J. Lamb.
9043	Busy Bee Brand, Pure Strained Honey,	Hudson Mfg. Co., 61 Hudson St., N. Y.
9380	Pure Honey, gathered from White Clover,	F. H. Strever, Pine Plains, N. Y.
9051	Health Brand, Pure Strained Honey.	Lewis DeGross & Son, New York.
9055	Pure Strained Honey. Guaranteed Free from adulteration,	Falcon Packing Co., New York.
9100	Pure Strained Honey,	F. C. Gould, East Hartford, Conn.
9238	Strained Honey,	F. H. Leggett & Co., New York.
9253	Pure Honey. With a bee as trade-mark,	None given.
9262	½ lb. Pure Honey (blown in glass),	None given.
9250	Pure White Clover Honey,	Brownell & Field Co., Providence, R. I.
9249	Choice Honey, Warranted,	None given.
9336	None. Piece of comb in it,	None given.
9349	Strictly Pure Honey,	Whitcher, Pillman & Co., Ayer, Mass.
9341	Pure Extracted Honey. From the apiary of	Geo. J. Francis, Durham, Conn.
9339	Pure Extracted Honey, Eagle Brand,	None given.
9281	Chas. McCulloch & Co., Wholesale Com- mission, Albany,	E. E. Harris, North Petersburg, N. Y.
9287	None. In pint Mason jar,	None given.
9307	Fancy California Honey,	C. T. Joslyn Co., Malden, Mass.
9291	None. Piece of comb in it,	None given.
9309	Pure Honeysuckle Honey,	W. J. Lamb.

* 13.024 grams.

STRAINED HONEYS.

Dealer.	Price per Package.	POLARIZATION.			
		Direct.		After Inversion.	
		Degrees.	Temperature C.	Degrees.	Temperature C.
<i>Bridgeport.</i> — Bridgeport Public Market,	.20	—0.1	24.0	—15.7	21.7
<i>Greenwich.</i> — Avery & Wilson,	.25	—4.3	23.7	—11.8	23.7
L. Timmons,	.25	—0.5	22.3	—17.9	23.0
<i>Middletown.</i> — A. M. Bidwell,	.30	—9.7	26.0	—12.4	25.4
<i>Stamford.</i> — W. W. Waterbury,	.32	—8.7	22.4	—14.0	21.5
<i>Bridgeport.</i> — Coe & White, 560 Main St.,	.15	—10.9	22.0	—15.1	23.0
Logan Bros., 863 Main St.,	.20	—12.7	25.5	—20.4	24.3
C. H. Stevens, 398 East Main St.,	.20	—16.7	23.0	—19.5	22.2
R. T. Whiting, 345 Main St.,	.25	—16.3	22.0	—16.8	22.0
<i>Canaan.</i> — Jackson & Eggleston,	.25	—10.3	24.3	—16.1	24.7
<i>Greenwich.</i> — Knapp & Studwell,	.20	—15.7	22.0	—19.3	22.0
J. L. Mahoney,	.20	—14.5	23.0	—17.9	23.0
<i>Hartford.</i> — Barrows & Thalheimer, 525 Main,	.15	—16.7	23.0	—22.3	23.0
H. J. Case & Co., 433 Main St.,	.25	—12.5	23.2	—18.4	22.6
<i>Meriden.</i> — L. C. Brown, 4 West Main St.,	.18	—15.7	25.3	—19.0	25.3
Kimball & Hugins, 31 East Main St.,	.15	—16.3	24.0	—19.9	22.2
N.Y. Butter & Grocery House, 2 Colony,	.15	—16.3	23.0	—21.9	23.5
J. J. Pagnam, 35 West Main St.,	.15	—10.3	23.0	—14.4	23.3
<i>Middletown.</i> — C. A. Allison, 31 Main St.,	.20	—17.1	23.0	—21.7	22.0
Cottage Market, Main St.,	.10	—18.9	21.5	—22.8	20.3
W. K. Spencer, Main St.,	.35	—10.1	25.4	—12.9	25.2
W. K. Spencer, Main St.,	.20	—14.7	22.0	—18.8	21.0
<i>New London.</i> — Daboll & Freeman,	.20	—11.7	25.8	—14.6	25.1
T. W. Potter, 72 State St.,	.28	—16.5	22.0	—20.1	22.6
<i>Norwich.</i> — H. I. Palmer, Main St.,	.20	—11.5	25.0	—17.5	25.0
G. A. Ray, 47 Shetucket St.,	.18	—18.8	24.5	—21.9	24.0
J. A. Stoddard, 100 Franklin St.,	.25	—14.3	25.2	—19.5	20.3

TABLE XX.

Station No.	Label.	Manufacturer or Producer.
<i>Contain Cane Sugar.</i>		
9047	Echo Brand Clover Honey, Guaranteed Pure,	Aero Distilled Water Co., Bridgeport.
9045	Echo Brand Clover Honey, Absolutely Pure,	Aero Distilled Water Co., Bridgeport.
<i>Consist of or Contain Glucose Syrup.</i>		
9024	* Choice Comb Honey,	Wm. Thompson, Wayne Co., N. Y.
9040	* Choice Comb Honey,	Wm. Thompson, Wayne Co., N. Y.
9026	No Label. Said to be	Deforth Bros., 41 First Ave., New York.
9277	Pure Strained Honey, F. H. Leggett & Co., Prop.,	Crystal Conserve Co., New York.
9288	White Clover Honey,	West Virginia Preserving Co., Wheeling.
9072	* Choice Extracted Honey,	Thomas Waters, Worcester, N. Y.
9074	White Clover Honey,	West Virginia Preserving Co.
9077	Extra Quality Pansy Brand Honey,	Not given.

* We have added a little crystal syrup with our honey to prevent granulation, which we guarantee perfectly pure and wholesome.

EXAMINATION OF MAPLE SYRUP.

By A. W. OGDEN.

Three samples of maple syrup have been examined, and all were found to be free from adulteration with glucose. The samples were the following:

7884. "Vermont Maple Syrup, Vermont Maple Sugar and Syrup Co., New Haven, Conn." Bought of P. Jente & Bro., 107 Broadway, New Haven.

9606. Warranted Pure Vermont Maple Syrup. Stoddard, Gilbert & Co., New Haven, Conn.

9607. Gold Leaf Brand Pure Vermont Maple Syrup. Huntington Maple Syrup and Sugar Co., Maple Groves, Huntington, Vt.

MILK EXAMINED FOR NEW HAVEN MILKMEN.

By A. W. OGDEN AND W. L. MITCHELL.

A New Haven city ordinance, passed in 1897, establishing a milk standard, was the means of awakening unusual interest among milk producers and dealers in the composition of the

STRAINED HONEYS.

Dealer.	Price per Package.	POLARIZATION.				Per cent. Sucrose by Polarization.
		Direct.		After Inversion.		
		Degrees.	Temperature C.	Degrees.	Temperature C.	
<i>Bridgeport.</i> — Bridgeport Public Market,	.25	30.9	22.5	—19.5	22.5	38.0
Centennial Tea Co.,	.15	22.3	21.3	—20.6	22.0	32.6
<i>Bridgeport.</i> — D. O'Donnell, 628 Main St.,	.10	82.9	24.6	78.4	23.5	....
The Village Market, Main St.,	.10	106.7	23.5	102.3	23.5	....
R. Wundrack, 575 Main St.,	.12	107.7	24.0	104.2	25.3	....
<i>New London.</i> — Keefe & Davis, 125 Bank St.,	.20	66.5	25.0	63.0	21.5	....
T. W. Potter, 72 State St.,	.10	125.5	22.0	121.3	21.5	....
<i>Stamford.</i> — W. W. Edwards, 99 Main St.,	.15	88.1	25.4	83.9	24.2	....
J. F. Maher, 7 Pacific St.,	.12	126.5	24.0	123.3	24.0	....
N. Y. Grocery Co., Main St.,	.10	127.1	24.0	123.8	24.0	....

milk which they sold, and since that time ninety-six samples have been sent to the Station for examination by dealers.

The Station has no guarantee that the samples were properly drawn, but as they were submitted for the private information of the senders, it is not likely that they were intentionally unfair samples.

The results of the examinations may be summarized as follows:

Month.	TOTAL SOLIDS. PER CENT.				BUTTER FAT. PER CENT.			
	No. Samples.	Average.	Highest.	Lowest.	No. Samples.	Average.	Highest.	Lowest.
1897								
December,	11	13.24	14.73	12.41	15	4.34	5.20	3.80
1898								
January,	13	13.11	14.32	12.06	21	4.19	5.35	3.20
February,	6	12.59	13.13	11.88	12	4.27	7.30	3.50
March,	6	13.68	14.31	12.66	9	4.49	5.20	3.40
April,	7	13.25	14.43	12.93	8	4.79	4.85	3.85
May,	8	12.98	14.03	11.55	13	4.70	5.35	3.60
June,	1	12.06	....	....	7	4.16	4.60	3.90
July,	..	....	....	....	6	4.45	5.10	3.80
August,	..	....	....	....	..	....	....	....
September,	1	13.60	....	....	4	4.59	5.00	4.00
Total and Average,	53	12.90	14.73	11.55	95	4.40	7.30	3.20

MILK DELIVERED AT A PUBLIC INSTITUTION.

BY A. W. OGDEN AND W. L. MITCHELL.

The contents of six forty-quart cans were carefully sampled by an agent of the Station as they were delivered at 5 A. M. by the milkman to the institution. The milk in the several cans contained the following percentages of fat: 5.30, 4.90, 3.75, 4.15, 4.60, and 3.50. The milk was, therefore, of good quality, though the contents of two cans fell below the seller's guarantee of four per cent. of butter fat. It is evident that the whole quantity of milk delivered, if mixed, would contain over four per cent. (about 4.36 per cent.).

From these cans milk is poured off for kitchen uses, and also for the table use of the inmates.

The milk sent up for table use in different parts of the institution, on the day when the milk supply was examined, contained the following percentages of fat: 4.2, 3.2, 3.6, 3.45, 3.5, 3.9, and 3.8.

It would appear that rather less butter fat is in the milk served at meals than is in the milk as it is delivered. Those in charge are instructed to stir the milk thoroughly each time before pouring from the can, but evidently a perfect mixture is not obtained.

CREAM.

BY A. W. OGDEN AND W. L. MITCHELL.

Seven samples of cream, sent to the Station for examination by private individuals, contained on the average 21.41 per cent. of butter fat, the percentages ranging from 18.9 to 26.75.

Two samples of concentrated cream contained 33.75 and 37.75 per cent. of butter fat respectively.

Fourteen samples of fresh cream not found to contain borax, were bought by the Station agent of the following dealers:

Station No.

9163	<i>Danbury</i> ,.....	East Canaan Creamery, 47 White St.
7938	<i>Hartford</i> ,.....	Allen Bros., Main and Sheldon Sts.
7945		J. P. Guilfoil Co., 193 Asylum St.
7948		G. F. Kellogg, 123 Ann St.
7921	<i>Meriden</i> ,.....	D. Higgins, 17 Butler St.
9175	<i>Naugatuck</i> ,.....	The Grant Grocery Co.

Station No.

7731	<i>New Haven</i> ,.....	S. J. Burt, 894 State St.
7855		J. T. Pohlman, 140 Dixwell Ave.
7724		A. Tenant, 751 State St.
7727		W. E. Waterbury, 774 State St.
7987	<i>New London</i> ,....	T. W. Potter, 72 State St.
7975		Thomas & Gumble, 437 Bank St.
9101	<i>Norwich</i> ,.....	W. A. Smith, 137 Main St.
7964	<i>Willimantic</i> ,....	Purinton & Reade, 717 Main St.

Four samples of fresh cream contained borax. These were the following:

7761, 7762. Two samples labeled on paper cap: "Goshen Farm Co. Pure Cream, Goshen, Conn." Dealers, Simon Bohl, 88 S. Main St., and the Waterbury Grocery Co., 165 Bank St., Waterbury. Price, 10 cents per half pint.

7849. Dealer, J. C. Kelley, Dixwell and Munson Sts., New Haven. Price, 10 cents per half pint.

7851. Dealer, C. Kipp, Dixwell Ave. and Henry St., New Haven.

The following brands of canned cream were found to contain neither borax, salicylic acid, nor benzoic acid:

7924. "Butler's Brand Condensed Cream." Dealer, Russell Bros., 2 Colony St., Meriden. Price, 10 cents per can.

7857. "Borden's Peerless Brand Evaporated Cream." Dealer, I. B. Chandler, 101 Dixwell Ave., New Haven. Price, 12 cents per can.

9106. "St. Charles Evaporated Cream." Dealer, H. D. Avery, 202 Franklin St., Norwich. Price, 15 cents per can.

9110. "Imperial Brand Cream, Anglo-Swiss Condensed Milk Co." Dealer, A. C. Stetson, Putnam. Price, 20 cents per can.

7967. "Highland Brand Evaporated Cream, Helvetia Milk Condensing Co." Dealer, H. C. Hall, Willimantic. Price, 15 cents per can.

CANNED SOUPS.

Thirty-two samples of canned soups were examined by Messrs. Winton, Ogden, and Mitchell to detect any chemical preservative, and in all cases with negative results.

The samples were as follows:

7923. Anderson's Concentrated Tomato Soup. Anderson

Preserving Co., Camden, N. J. Dealer, Russell Bros., 2 Colony St., Meriden. Price, 10 cents per can.

7908, 7909, 7910. French Soups. Franco-American Food Co., New York. Dealer, P. Jente & Bro., 107 Broadway, New Haven. Price, 35 cts. per quart can.

7903 to 7907. White Label Soups. Armour Packing Co., Kansas City. Dealer, P. Jente & Bro., 107 Broadway, New Haven. Price, 23 cents per quart can.

7860 to 7871. French Soups. Franco-American Food Co., New York. Dealer, E. E. Hall & Son, 770 Chapel St., New Haven. Price, 20 cents per pint, and 32 cents per quart cans.

7872 to 7882. Huckins' Soups. J. H. W. Huckins & Co., Boston. Dealer, S. W. Hurlburt, 1074 Chapel St., New Haven. Price, 25 cents per quart can.

CHILI SAUCE.

9375. "Heinz's Chili Sauce. Keystone Brand. H. S. Heinz, Pittsburg." Dealers, S. L. Parsons & Son, Canaan. Price, 25 cents per bottle. Contained *eosine* (a dye much used in red ink) and *salicylic acid*.

CANNED VEGETABLES.

Twenty-three samples of canned peas, twenty-five of corn, seven of string beans, three of lima beans, and seven of succotash (lima beans and corn) were examined by Messrs. Winton, Ogden, and Mitchell, for preservatives. Sulphurous acid was present in small amount in some of the samples of canned corn, but other than this, no preservative was detected.

MINCE MEAT.

Nine samples of mince meat were examined by Messrs. Winton, Ogden, and Mitchell, to detect the presence of salicylic

and boric acids, but in every case with negative results. The samples were as follows :

TABLE XXI.—MINCE MEAT NOT FOUND TO CONTAIN SALICYLIC OR BORIC ACIDS.

Station No.	Brand.	Dealer.	Price per package.
9167	Health Brand Mince Meat, Lewis DeGross, New York, . . .	<i>Danbury.</i> Mastin & Co., 54 White St.,	10
7858	Columbia Condensed Mince Meat, Gutchess Bros., Port Byron, N. Y.,	<i>New Haven.</i> C. T. Downes & Sons, 1 Broadway,	9
7805	The Old Homestead Condensed Mince Meat, Libby, McNeill & Libby, Chicago,	Philip Hugo, 28 Edwards St.,	10
7911	None Such New England Mince Meat, Merrell-Soule Co., Syracuse, N. Y.,	P. Jente & Bro., 107 Broadway,	9
7820	Condensed Mince Meat, Armour & Co., Chicago,	Kohn Bros., 55 George St.,	10
7822	New England Condensed Mince Meat, T. E. Dougherty, Chicago,	D. M. Welch & Son, 28 Congress Ave.,	10
7758	The Superb Mince Meat, Hudson Valley Preserving Co., Glens Falls, N. Y.,	<i>Waterbury.</i> Dixon & Sanson, 328 Washington St.,	10
7749	Imperial Condensed Mince Meat, Gutchess Bros., Port Byron, N. Y.,	E. J. Upson, 841 N. Main St.,	10
7370	The Unequalled Mince Meat, E. Harrison, Glens Falls, N. Y.,	<i>Willimantic.</i> Burt Thompson, 798 Main St.,	10

GROUND SPICES IN SEALED AND LABELED PACKAGES.

BY A. L. WINTON AND W. L. MITCHELL.

Of 332 samples of spices sold *in bulk* which have been examined at this Station during the past three years, 127, or 38.3 per cent. of the whole number, have been found adulterated. If samples of mustard colored with turmeric are included, the number of adulterated samples will be increased to 138, or 41.5 per cent. of the whole number examined.

As the purchaser has no ready means of distinguishing between the pure and the adulterated, his only safe course is to buy spices in *sealed packages, bearing the name of a reliable house whose goods have not been found adulterated.*

In Table XXII are given the results obtained in the examination of all the brands of mustard, black pepper, white pepper, cayenne pepper, cloves, allspice, cinnamon, and nutmeg which have been found on sale in this State in sealed and labeled packages. With the exception of 19 samples of black pepper collected in 1896, all of these samples have been collected and examined within the year covered by this report.

Results of examination of 25 samples of ginger sold in sealed and labeled packages will be found in Tables XI, XII, and XIV, pages 147-150.

The samples noticed in this report are the following :

Mustard,	26 samples.
Black pepper,	44 "
White pepper,	13 "
Cayenne pepper,	14 "
Cloves,	20 "
Allspice,	21 "
Cinnamon,	26 "
Nutmeg,	6 "
<hr/>	
Total,	170 "

The methods of chemical analysis employed are described on pages 186 to 191.

A summary of the samples of ground spices examined at this Station during the past three years is as follows:

SUMMARY OF EXAMINATION OF SPICES.

1896-1899.

	Number of Samples Examined.	Number of Samples found Adulterated or "Compounded."	Per cent. of Samples Adulterated or "Compounded."
In bulk,	332	138	41.5
In labeled packages,	242	57	23.5

TABLE XXII—SPICES BOUGHT IN

Station No.	Brand.	Dealer.
<i>Mustard.</i>		
9295	Anco Spice Mills, N. Y., Perfectly Pure Mustard,	<i>Norwich.</i> A. Wilson, 58 Franklin St.,
9745	Angur, John P., New Haven, Crescent Mills, Pure Mustard,	<i>New Haven.</i> J. G. & J. W. Pohlman, 140 Dixwell Ave.,
9746	Bailey, C. A., Strictly Pure Mustard,	C. A. Bailey, 171 Dix'll Ave.,
9490	Bennett, Simpson & Peek, London, Double Strength Mustard,	<i>Waterbury.</i> The Hewitt Grocery Co., 20 N. Main St.,
9742	Born Bros., Erfurt, Germany, Born's Mustard,	<i>New Haven.</i> Greater N. Y. Del. & Prov. Co., 84 Cong. Ave.,
9431	Bushnell Co., The F. C., Absolutely Pure Mustard,	I. B. Chandler, 101 Dix'll Ave.,
9251	Butler, James, New York, Strictly Pure Mustard,	<i>Meriden.</i> N. Y. Butter & Grocery House, 2 Colony St.,
9476	Colburn Co., The A., Phila., Colburn's Mustard,*	<i>Hartford.</i> Boston Grocery Co., Main St.,
9427	J. Colman's Mustard, England,†	<i>New Haven.</i> G. J. Burt, 894 State St.,
9318	Daniels, Cornell & Co., Strictly Pure Mustard,	<i>Putnam.</i> J. E. Sullivan.
9508	Dean & Son, N. Y., Ardenter Mustard,	<i>Groton.</i> H. E. Marquardt.
9744	Durkee & Co., E. R., N. Y. Gauntlet Brand Mustard Flour,	<i>New Haven.</i> C. Kipp, 290 Dixwell Ave.,
9740	Farrington & Co., F. R., N. Y. & Boston, Imperial Mustard,	F. W. Miner, 61 Broadway,
9271	Gillies & Co., Edwin J., N. Y. Mustard, Absolutely Pure,	<i>New London.</i> A. E. Foster, 120 Main St.,
9477	Hills & Co., Gold Seal Mustard,	<i>Hartford.</i> Hills & Co., 372 Asylum St.,
9480	Keen's Mustard, Double Superfine, London,‡	Hills & Co., 372 Asylum St.,
9743	Leggett & Co., Francis H., N. Y., Best Mustard,	<i>New Haven.</i> C. T. Downes & Son, 1 Broadway,
9506	Lincoln, Seyms & Co., Hartford,	<i>Portland.</i> P. Sullivan,
9452	Slade Co., D. & L., Boston, Oxford Mustard, Absolutely Pure,	<i>New Britain.</i> Sovereign Trading Co., 282 Main St.,
9468	Stickney & Poor, Boston, Absolutely Pure Mustard,	<i>Forestville.</i> J. M. Todd,
9739	Stoddard, Gilbert & Co., New Haven, Pure Mustard,	<i>New Haven.</i> N. Francesconie, Congress Ave.,
9493	Sultana Spice Mills, A. & P. Mustard,	<i>Waterbury.</i> Atlantic & Pacific Tea Co., 31 E. Main St.,
9470	Union Spice Co., New York, Celebrated Mustard,	<i>Hartford.</i> Union Pacific Tea Co., 174 Asylum St.,
9459	Upson Bros., Absolutely Pure Mustard,	<i>Southington.</i> Upson Bros.,
9741	Welch & Son, D. M., Absolutely Pure Mustard,	<i>New Haven.</i> D. M. Welch & Sons, Congress Ave.,
9738	Genuine English Mustard,	B. Carari & Co., 123 Congress Ave.,

* "The finest compound for family or medicinal use."

† "Warranted to be the finest Mustard Compound."

‡ "This is an admixture in which no injurious ingredient is used."

SEALED AND LABELED PACKAGES.

Station No.	Price per pack. — cts.	Ounces in package.	A			Ether extract.	Reducing matters by direct inversion calculated as starch.	"Starch" by diastase method.	Crude fiber.	Nitrogen $\times 6\%$.	Remarks.
			Total.	Volatile.	Non-volatile.						
9295	12	4	6.76	0.61	21.10	5.22	1.92	1.67	39.56		Colored with turmeric.
9745	10	4	6.26	0.33	19.17	5.18	2.08	2.15	39.75		Not found adulterated.
9746	10	4	5.85	0.05	19.24	4.14	0.51	2.59	41.06		do
9490	15	4	6.21	1.33	18.04	3.78	0.84	2.58	40.93		do
9742	15	4	4.81	1.90	21.98	1.85	0.28	1.95	40.63		do
9431	9	4	6.88	0.00	21.53	4.77	0.96	3.41	38.63		do
9251	10	4	4.60	0.54	10.34	33.71	30.26	1.97	23.63		Wheat flour about 40% §
9476	12	4	5.20	0.19	18.66	18.50	15.52	1.80	32.44		Wheat flour about 20% § turmeric.
9427	18	4	3.83	0.00	35.16	10.17	7.54	1.78	30.00		Wheat flour about 9% §
9318	20	8	5.54	0.38	17.95	6.12	1.74	4.87	39.25		Not found adulterated.
9508	10	4	5.16	0.38	20.89	3.65	0.67	1.76	42.13		do
9744	10	4	5.23	0.34	21.26	3.11	0.84	1.61	42.13		Colored with turmeric.
9740	10	4	5.69	0.56	20.27	4.19	0.57	2.02	39.88		Not found adulterated.
9271	10	4	14.05	0.28	21.32	4.18	1.41	2.68	35.37		Sand 7.24%.
9477	15	4	5.09	0.26	17.42	4.86	1.57	2.59	43.56		Not found adulterated.
9480	15	4	3.92	0.00	34.65	8.87	7.03	1.85	31.00		Wheat flour about 8% §
9743	10	4	5.61	0.27	27.64	2.97	0.28	1.58	36.63		Not found adulterated.
9506	12	4	7.35	0.86	26.18	4.23	1.12	2.26	35.63		do
9452	20	4	6.92	0.81	17.50	5.27	1.12	2.70	38.69		do
9468	10	4	5.58	0.51	20.37	4.77	1.18	3.17	39.81		do
9739	10	4	6.95	0.53	18.58	4.59	1.24	2.45	39.31		do
9493	10	2½	6.58	0.26	17.14	5.54	1.80	3.35	40.49		do
9470	10	2½	7.44	0.00	16.00	7.79	1.74	6.15	36.75		Colored with turmeric.
9459	15	4	5.36	0.00	28.10	3.55	0.67	2.54	37.13		Not found adulterated.
9741	7	2½	5.92	1.07	20.47	4.05	1.74	1.98	39.25		do
9738	10	4	6.05	0.67	18.44	4.55	0.95	2.48	39.44		do

§ Calculated from the percentage of starch (by the diastase method) assuming that mustard contains 1 per cent. and wheat flour 70 per cent. of starch.

TABLE XXII — SPICES BOUGHT IN

Station No.	Brand.	Dealer.
	<i>Black Pepper.</i>	
5590	Adams & Howe, N. Y., Pure Pepper.	<i>Danbury.</i> 79 White St.,
9467	Allyn & Blanchard Co., Hartf'd, Pepper.	<i>Southington.</i> Finch & Laity,
5573	Augur, John P., New Haven, Crescent Mills, Pure Pepper.	<i>Waterbury.</i> Foote & Westwood, W. Main St.,
5574	Austin, Nichols & Co., N. Y., Blue Ribbon Pure Black Pepper.	<i>Putnam.</i> George Farley,
5595	Barnum & Reed, Strictly Pure Pepper.	<i>Danbury.</i> Barnum & Reed, 307 Main St.,
5596	Batthey & Son, L., Strictly Pure Pepper.	<i>Moosup.</i> L. Batthey & Son,
5569	Bennett, Simpson & Co., London, Genuine Malabar Black Pepper.	<i>Waterbury.</i> Waterbury Grocery Co., 163 Bank St.,
5071	Bennett, Sloan & Co., N. Y., Pure Pepper.	<i>New Haven.</i> Geo. M. Coombs, 195 Whalley Ave.,
5567	Blanchard, O. H., Pepper.	<i>Willimantic.</i> H. Dillon,
5570	Boardman & Sons, Hartford, Pure Pepper.	<i>New Britain.</i> J. Kerrin, 62 North St.,
5577	Bryan, Miner & Read, New Haven, Ground Black Pepper, warranted pure.	<i>Derby.</i> P. McEnerney, Main St.,
5581	Bryan, Miner & Read, New Haven, Pure Black Pepper.	<i>Willimantic.</i> Holden Arnold,
9520	Bugbee & Brownell, Providence, Pure Black Pepper.	<i>Norwich.</i> A. T. Otis, 261 Main St.,
9425	Bushnell Co., The F. C., New Haven, Absolutely Pure Pepper.	<i>New Haven.</i> F. E. Hull, 399 Grand Ave.,
9252	Butler, James, N. Y., Compound Pepper	<i>Meriden.</i> N. Y. Butter & Grocery House, 2 Colony St.,
9415	Clark, Chapin & Bushnell, N. Y., Diamond Absolutely Pure Pepper.	<i>Ansonia.</i> W. H. Bronson, 234 Main St.,
9433	Colburn Co., The A., Phila., Choicest Shot Pepper.	<i>New Haven.</i> G. J. Burt, 894 State St.,
9509	Daniels, Cornell & Co., New London, Strictly Pure Pepper.	<i>Groton.</i> G. S. Avery,
9086	De Groff, Lewis, N. Y., Best Pepper.	<i>Stamford.</i> H. Sawyer Daskam,
5583	Durkee & Co., E. R., N. Y., XXX Pepper.	<i>Meriden.</i> Thomas Nolan, 250 Pratt St.,
9320	Exley, Watkins & Co., Wheeling, W. Va.	<i>Putnam.</i> Edward Mullan,
9233	Farrington & Co., F. R., N. Y. & Boston, Pure Black Pepper.	<i>New Haven.</i> S. S. Adams, 412 State St.,
9273	Gillies & Co., Edwin J., N. Y., Absolutely Pure Pepper.	<i>New London.</i> A. E. Foster, 120 Main St.,
9802	Hall & Son, E. E., Singapore Black Pepper.	<i>New Haven.</i> E. E. Hall & Son,
9482	Hills & Co., Gold Seal Pepper.	<i>Hartford.</i> Hills & Co., 372 Asylum St.,
9282	Hornick, E. P., N. Y., Pure Pepper.	<i>New London.</i> Wm. A. Holt, 50 Main St.,

SEALED AND LABELED PACKAGES—*Continued.*

Station No.	Price per package.	Ounces in package.	Ash.		Ether extract—non-volatile.	Crude fiber.	Remarks.
			Total.	Insoluble in HCl (Sand).			
5590	10	4	5.93	..	8.34	14.48	Not found adulterated.
9467	10	2½	6.26	....	7.93	15.52	do
5573	10	4	3.90	....	7.65	10.90	do
5574	10	4	4.60	...	8.15	12.72	do
5595	12	4	4.68	....	6.62	13.53	do
5596	8	4	3.94	....	7.09	13.70	do
5569	10	4	4.65	....	8.09	12.84	do
5071	..	.	4.96	....	7.02	14.30	do
5567	10	4	4.71	....	7.26	13.10	do
5570	10	4	4.10	....	7.84	12.86	do
5577	10	4	4.17	....	7.30	12.70	do
5581	10	4	5.23	....	7.81	15.41	do
9520	10	4	3.91	....	7.77	7.64	do
9425	10	4	5.25	....	7.52	13.98	do
9252	15	8	4.65	....	5.68	16.25	Contains buckwheat and wheat products.
9415	10	4	4.26	....	8.98	10.08	Not found adulterated.
9433	15	*3½	7.61	....	7.07	14.51	do
9509	10	4	8.30	1.09	5.89	22.16	Contains dirt or pepper shells.
9086	10	4	6.54	....	9.37	16.76	Not found adulterated.
5583	10	4	5.75	....	7.62	12.84	do
9320	10	*2	5.86	....	7.35	16.44	do
9233	5	4	6.67	....	6.54	15.31	do
9273	10	4	11.38	5.21	7.84	16.27	Contains dirt or pepper shells.
9802	..	.	.....	.....	.....	.....	Not found adulterated.
9482	20	*2	4.49	....	7.12	11.52	do
9282	10	4	4.84	...	8.05	12.68	do

* In glass pepper-shaker.

TABLE XXII — SPICES BOUGHT IN

Station No.	Brand.	Dealer.
<i>Black Pepper — Continued.</i>		
9803	Justice Mills, Absolutely Pure Black Pepper.	New Haven. Harry Leigh, 354 State St.,
9510	Leggett & Co., Francis H., N. Y., Best Black Pepper.	Madison. F. C. Dowd,
5576	Lincoln, Seyms & Co., Hartford, Pepper.	Waterbury. E. F. Platt, 37 E. Main St.,
5597	Lyon, C. H., Strictly Pure Pepper.	New London. C. H. Lyon, 42 Coit St.,
5591	Mansfield & Co., W. H., Pure Black Pepper.	Putnam. W. H. Mansfield & Co.,
5599	Palmiter, R. R., Excelsior Mills, Strictly Pure Pepper.	Derby. George M. Spring, 214 Main St.,
9285	Potter-Parlin Co., The, N. Y., Strictly Pure Pepper.	New London. T. W. Potter, 72 State St.,
5585	Powers & Co., Jas. G., N. Y., Red Shield Pepper.	Norwich. G. A. Ray,
5568	Slade Co., D. & L., Boston, Absolutely Pure Pepper.	Willimantic. Holden Arnold,
9450	Sovereign Trading Co., Pure Black Pepper.	New Britain. Sovereign Trading Co., 282 Main St.,
9207	Square Deal Mills, N. Y., Pure Pepper.	New Haven. S. S. Adams, 412 State St.,
9259	Stickney & Poor, Boston, Absolutely Pure Pepper.	Meriden. F. W. Miner, 213 Pratt St.,
9084	Stiff & Co., Wm. J., N. Y., Knickerbocker Pure Pepper.	Stamford. H. Sawyer Daskam,
9423	Sultana Spice Mills, A. & P. Pepper.	New Haven. Atlantic & Pacific Tea Co., 386 State St.,
5593	Swain, Earle & Co., Boston, Pure Pepper.	Preston. James M. Young,
9447	Tropical Mills, Boston, Select Compounded Pepper.	Wallingford. Laden Bros.,
9330	Union Pacific Tea Co., N. Y., Pure Sovereign Black Pepper.	Putnam. The U. P. Tea Co.,
9461	Upson Bros., Absolutely Pure Black Pepper.	Southington. Upson Bros.,
<i>White Pepper.</i>		
9420	Augur, John P., New Haven, Crescent Mills, White Pepper, warranted pure.	New Haven. Conrad Rausch, Foster & Avon Sts.,
9219	Bennett, Simpson & Co., London, Genuine Tellicherry White Pepper.	Johnson & Bro., 411 State St.,
9517	Bugbee & Brownell, Providence, Pure White Pepper.	Norwich. H. I. Palmer, 231 Union St.,
9228	Farrington & Co., F. R., N. Y. & Boston, Pure White Pepper.	New Haven. S. S. Adams, 412 State St.,
9481	Hills & Co., Gold Seal White Pepper.	Hartford. Hills & Co., 372 Asylum St.,

SEALED AND LABELED PACKAGES—*Continued.*

Station No.	Price per package.	Ounces in package.	Ash.		Ether extract—non-volatile.	Crude fiber.	Remarks.
			Total.	Insoluble in HCl (Sand).			
9803	8	8	.....	.....	.....	.....	Not found adulterated.
9510	10	4	5.16	.....	6.91	11.76	do
5576	10	4	4.82	.....	7.11	12.85	do
5597	10	4	3.97	.....	6.76	12.23	do
5591	10	4	4.46	.....	7.96	12.73	do
5599	12	4	5.87	.....	8.06	12.60	do
9285	10	*3½	7.47	.....	7.54	14.91	do
5585	9	4	5.88	.....	8.33	14.50	do
5568	10	4	4.21	.....	7.66	12.48	do
9450	10	4	5.55	.....	6.81	12.63	do
9207	10	4½	6.96	.....	7.58	14.25	do
9259	10	2½	4.50	.....	7.64	10.94	do
9084	12	*2½	6.76	.....	9.81	17.99	do
9423	10	2½	9.65	2.26	8.20	16.12	Contains dirt or pepper shells.
5593	10	4	4.22	.....	7.32	12.80	Not found adulterated.
9447	10	3	6.46	...	5.20	17.40	Contains charred matter, mustard hulls, and some corn product.
9330	20	8	9.37	2.93	6.59	16.69	Contains dirt or pepper shells.
9461	10	4	5.09	.....	6.76	11.93	Not found adulterated.
9420	10	4	2.25	.....	6.12	3.23	Adulterated with a wheat product.
9219	15	4	1.18	.....	7.46	2.46	Not found adulterated.
9517	12	4	1.39	.....	7.88	6.49	do
9228	5	4	4.01	...	6.19	3.60	do
9481	20	2*	3.43	.....	6.80	4.07	do

* In glass pepper-shaker.

TABLE XXII—SPICES BOUGHT IN

Station No.	Brand.	Dealer.
<i>White Pepper—Continued.</i>		
9475	Leggett & Co., Francis H., N. Y., Best White Pepper.	Hartford. Guilfoil Grocery Co., 184 Asylum St.,
9297	Leggett & Co., Francis H., N. Y., White Pepper.	Norwich. W. A. Church, 18 Market St.,
9061	Montanye & Co., W. H., N. Y., Positively Pure Pepper.	Greenwich. J. L. Mahoney,
9507	Powers & Co., Jas. S., N. Y., Red Shield White Pepper.	New London. Ed. Keefe, 495 Bank St.,
9524	Slade Co., D. & L., Boston, Absolutely Pure White Pepper.	New Haven. Philip Hugo, 26 Edward St.,
9293	Smith, Welcome A., The Finest White Pepper.	Norwich. Welcome A. Smith, 137 Main St.,
9471	Union Spice Co., N. Y., Celebrated White Pepper.	Hartford. Un. Pacific Tea Co., 174 Asylum St.,
9458	Upson Bros., Absolutely Pure White Pepper.	Southington. Upson Bros.,
<i>Cayenne Pepper.</i>		
9464	Allyn & Blanchard Co., Hartford, Strictly Pure Cayenne.	Southington. Finch & Laity.
9312	Austin, Nichols & Co., New York, Hungarian Paprika, Sweet Pepper.	Norwich. A.T. Otis, 261 Main St.
9504	Bryan, Miner & Read, New Haven, Pure Cayenne.	Portland. C. A. Ahlquist.
9518	Bugbee & Brownell, Providence, Pure Cayenne Pepper.	Norwich. A.T. Otis, 261 Main St.
9512	Ellis, S. N., New London, Pequot Brand Cayenne Pepper.	Groton. H. E. Marquiat.
9274	Gillies Mills, N. Y., Absolutely Pure Cayenne Pepper.	New London. A. E. Foster, 120 Main St.
9478	Hills & Co., Gold Seal Cayenne.	Hartford. Hills & Co., 372 Asylum St.
9342	Lincoln, Seyms & Co., Hartford, Pure Cayenne.	Middletown. J. B. Patterson, 110 Main St.
9058	Montanye & Co., W. H., New York, Pure Cayenne.	Greenwich. J. L. Mahoney.
9421	Slade Co., D. & L., Boston, Absolutely Pure Cayenne.	New Haven. Conrad Rausch, Foster & Avon Sts.
9351	Stickney & Poor's Absolutely Pure Cayenne.	Middletown. G. E. Burr, 136 Main St.
9412	Stickney & Poor's Pure Cayenne.	Ansonia. D. M. Welch & Son, Main St.
9417	Thompson's Pure Cayenne.	W. H. Bronson, 234 Main St.
9489	Manufacturer not given, Ground Cayenne.	Waterbury. The Hewitt Grocery Co., 20 N. Main St.

SEALED AND LABELED PACKAGES.

Station No.	Price per package.	Ounces in package.	Ash.		Ether extract—non-volatile.	Crude fiber.	Remarks.
			Total.	Insoluble in HCl (Sand).			
9475	13	4	1.16	....	7.77	0.53	Not found adulterated.
9297	20	5*	2.51	....	8.27	4.40	do
9061	10	4	3.22	....	6.78	3.77	do
9507	10	4	2.15	....	4.07	4.24	do
9524	15	2½	1.52	....	6.65	3.50	do
9293	15	4	1.09	....	7.53	0.70	do
9471	10	3	2.77	....	6.36	3.84	do
9458	15	4	1.08	....	7.63	0.43	do
9464	10	3	7.18	....	18.09	....	Not found adulterated.
9312	20	5*	6.76	....	15.59	....	do.
9504	12	4	7.62	....	16.05	....	do.
9518	12	4	5.88	....	17.53	....	do.
9512	10	4	7.00	....	19.02	....	do.
9274	10	4	6.02	....	19.14	....	do.
9478	15	4	8.34	....	15.82	....	do.
9342	10	1½	6.12	....	18.18	....	do.
9058	15	4	7.15	....	16.86	....	do.
9421	10	3	6.41	....	17.48	....	do.
9351	10	2*	6.56	....	17.45	....	do.
9412	10	1½	7.14	....	17.15	....	do.
9417	8	1½	6.54	....	17.52	....	do.
9489	10	1½	5.99	....	18.44	....	do.

* In glass pepper-shaker.

TABLE XXII—SPICES BOUGHT IN

Station No.	Brand.	Dealer.
	<i>Cloves.</i>	
9463	Allyn & Blanchard Co., Hartford, Strictly Pure Cloves.	<i>Southington.</i> Finch & Laity.
9455	Austin, Nichols & Co., New York, Blue Ribbon Pure Penang Cloves.	<i>New Britain.</i> Boston Branch Grocery, 238 Main St.
9221	Bennett, Simpson & Co., London, Genuine Amboyna Cloves.	<i>New Haven.</i> Johnson & Bro., 411 State St.
9498	Bransfield, John, Strictly Pure Cloves.	<i>Portland.</i> John Bransfield.
9496	Bushnell Co., The F. C., New Haven, Absolutely Pure Cloves.	<i>Waterbury.</i> Thos. Gray, 26 N. Main St.
9183	Clark, Holly & Ketchum, New York, Reliable Cloves.	<i>New Haven.</i> Coe & Jenks, 422 State St.
9434	Colburn Co., The A., Philadelphia, Choicest Amboyna Cloves.	G. J. Burt, 894 State St.
9429	Durkee & Co., E. R., New York, XXX Cloves.	do.
9232	Farrington & Co., F. R., New York and Boston, Pure Cloves.	S. S. Adams, 412 State St.
9495	Gray, Thomas, Strictly Pure Cloves.	<i>Waterbury.</i> Thos. Gray, 26 N. Main St.
9483	Hills & Co., Gold Seal Cloves.	<i>Hartford.</i> Hills & Co., 372 Asylum St.
9062	Leggett & Co., Wm. A., Pure Cloves.	<i>Greenwich.</i> L. Timmons.
9505	Lincoln, Seyms & Co., Hartford, Pure Cloves.	<i>Portland.</i> C. A. Ahlquist.
9059	Montayne & Co., W. H., New York, Pure Cloves.	<i>Greenwich.</i> J. L. Mahoney.
9526	Slade Co., D. & L., Boston, Absolutely Pure Cloves.	<i>New Haven.</i> I. B. Chandler, 101 Dixwell ave.
7451	Sovereign Trading Co., Pure Cloves.	<i>New Britain.</i> Sovereign Trading Co., 282 Main St.
9469	Stickney & Poor, Boston, Absolutely Pure Cloves.	<i>Forestville.</i> J. N. Todd.
9492	Sultana Spice Mills, A. & P., Cloves.	<i>Waterbury.</i> Atlantic & Pacific Tea Co., 31 E. Main St.
9472	Union Spice Co., New York, Celebrated Compound Cloves.	<i>Hartford.</i> Union Pacific Tea Co., 174 Asylum St.
9460	Upson Bros., Absolutely Pure Cloves.	<i>Southington.</i> Upson Bros.
	<i>Allspice.</i>	
9466	Allyn & Blanchard Co., Hartford, Strictly Pure Allspice.	<i>Southington.</i> Finch & Laity.
9209	Augur & Tuttle, New Haven, Crescent Mills Pure Allspice.	<i>New Haven.</i> S. S. Adams, 412 State St.
9220	Austin, Nichols & Co., New York, Blue Ribbon Pure Allspice.	Johnson & Bro., 411 State St.

SEALED AND LABELED PACKAGES.

Station No.	Price per package, cents.	Ounces in package.	ASH.		ETHER EXTRACT.		Remarks.
			Total.	Insoluble in HCl. (Sand).	Volatile.	Non-volatile.	
9463	10	3	7.23	....	13.82	7.19	Not found adulterated.
9455	10	4	7.92	....	12.58	5.78	do.
9221	10	4	6.52	....	17.27	6.30	do.
9448	10	4	5.88	....	14.01	6.49	Adulterated with wheat product.
9496	10	4	7.31	....	13.03	6.12	Not found adulterated.
9183	15	4	5.99	....	16.77	6.31	do.
9434	15	3½*	8.80	1.25	9.25	7.90	Contains clove stems.
9429	10	2½	7.44	....	11.32	4.87	Not found adulterated.
9232	5	4	7.82	....	8.91	6.97	Contains clove stems.
9495	10	4	8.32	1.07	9.76	6.08	do.
9483	20	2*	6.54	....	16.03	5.86	Not found adulterated.
9062	10	4	4.76	....	1.43	4.49	Adulterated with allspice.
9505	15	4	9.42	2.06	6.19	6.38	Contains clove stems.
9059	10	4	6.59	....	18.25	5.61	Not found adulterated.
9526	9	4	7.47	....	11.03	5.78	do.
7451	10	4	7.43	....	14.71	6.68	do.
9469	10	4	7.19	....	14.19	6.11	do.
9492	10	2½	6.39	....	11.95	5.21	do.
9472	10	3	7.00	....	7.25	5.21	Contains ground cocoanut shells & starchy matter.
9460	14	4	6.90	....	16.57	5.84	Not found adulterated.
9466	10	3	5.14	....	1.47	5.50	do.
9209	10	4	9.20	1.09	1.49	3.85	Adulterated with ground cocoanut shells.
9220	10	4	5.56	....	2.49	4.15	Not found adulterated.

* In glass pepper-shaker.

TABLE XXII—SPICES BOUGHT IN

Station No.	Brand.	Dealer.
	<i>Allspice*—Continued.</i>	
9516	Bennett, Simpson & Co., London, Genuine Pimento or Allspice.	Norwich. H. I. Palmer, 231 Union St.
9016	Birdsey, C. K., Bridgeport, Allspice.	Bridgeport. Centennial Tea Co., 856 Main St.
9499	Bransfield, John, Strictly Pure Allspice.	Portland. John Bransfield.
9435	Colburn Co., The A., Philadelphia, Choicest Jamaica Allspice.	New Haven. G. J. Burt, 894 State St.
9428	Durkee & Co., E. R., Allspice.	do.
9231	Farrington & Co., F. R., New York and Boston, Pure Allspice.	S. S. Adams, 412 State St.
9479	Hills & Co., Gold Seal Allspice.	Hartford. Hills & Co., 372 Asylum St.
9491	Howard & Co., New York, Pure Jamaica Allspice.	Waterbury. The Hewitt Grocery Co., 20 N. Main St.
9502	Kibbe & Co., E. S., Hartford, Pure Allspice.	Portland. C. A. Ahlquist.
9515	Pinckney & Co., H. F. A., London, Allspice.	Norwich. W. A. Church, 20 Market St.
9446	Slade Co., D. & L., Boston, Absolutely Pure Allspice	Wallingford. Laden Bros.
9448	Sovereign Trading Co., Pure Allspice.	New Britain. Sovereign Trading Co., 282 Main St.
9208	Square Deal Pure Spices, Allspice.	New Haven. S. S. Adams, 412 State St.
9426	Stickney & Poor's Pure Allspice.	D. M. Welch & Son, 8 Grand Ave.
9424	Sultana Spice Mills, A. & P., Allspice.	Atlantic & Pacific Tea Co., 386 State St.
9333	Tiger Mills, New York, Pure Allspice.	Putnam. A. G. Stetson.
9473	Union Spice Co., New York, Celebrated Allspice.	Hartford. Union Pacific Tea Co., 174 Asylum St.
9462	Upson Bros., Absolutely Pure Allspice.	Southington. Upson Bros.

SEALED AND LABELED PACKAGES—*Continued.*

Station No.	Price per package, cents.	Ounces in package.	ASH.		ETHER EXTRACT.		Remarks.
			Total.	Insoluble in HCl. (Sand).	Volatile.	Non-volatile.	
9516	15	4	4.54	....	2.16	6.22	Not found adulterated.
9016	10	4	4.11	....	2.75	3.02	Adulterated with ground cocoanut shells.
9499	10	4	4.74	...	2.55	5.00	Not found adulterated.
9435	15*	3½	6.31	.40	2.93	5.66	do.
9428	10	2½	7.51	.95	1.34	3.79	do.
9231	5	4	5.96	...	3.50	3.48	do.
9479	12	4	4.75	...	3.35	3.91	do.
9491	15	4	4.59	...	1.40	6.27	do.
9502	12	4	5.18	....	1.77	5.77	do.
9515	15	4	5.71	....	1.67	4.92	do.
9446	10	4	4.34	...	1.35	4.20	do.
9448	10	4	4.98	....	2.84	3.22	do.
9208	10	4½	9.34	1.52	2.17	3.57	Adulterated with clove stems.
9426	10	2½	4.96	....	3.39	3.68	Not found adulterated.
9424	10	2½	5.05	...	2.22	4.07	do.
9333	18	8	4.52	....	2.49	3.78	do.
9473	10	3	9.62	2.95	3.94	3.17	Too much sand.
9462	10	4	5.74	....	2.06	3.36	Not found adulterated.

* In glass pepper-shaker.

TABLE XXII.—SPICES BOUGHT IN

Station No.	Brand.	Dealer.
	<i>Cinnamon.</i>	
9465	Allyn & Blanchard Co., Hartford, Strictly Pure Cinnamon.	<i>Southington.</i> Finch & Laity.
9419	Augur, John P., New Haven, Crescent Mills Pure Cinnamon.	<i>New Haven.</i> Philip Hugo, 11 Edwards St.
9050	Austin, Nichols & Co., New York, Blue Ribbon Pure Cinnamon.	<i>Greenwich.</i> Knapp & Studwell.
9085	Beard & Co., Samuel S., New York, Pure Cinnamon.	<i>Stamford.</i> H. Sawyer Daskam.
9222	Bennett, Simpson & Co., London, Genuine Penang Cinnamon.	<i>New Haven.</i> Johnson & Bro., 411 State St.
9503	Bryan, Miner & Read, New Haven, Pure Cassia.	<i>Portland.</i> C. A. Ahlquist.
9519	Bugbee & Brownell, Providence, Pure Cinnamon.	<i>Norwich.</i> A. T. Otis, 261 Main St.
9497	Bushnell Co., The F. C., New Haven, Absolutely Pure Cinnamon.	<i>Waterbury.</i> Thos. Gray, 26 N. Main St.
9416	Clark, Chapin & Bushnell, New York, Pure Cinnamon.	<i>Ansonia.</i> W. H. Bronson, 234 Main St.
9184	Clark, Chapin & Bushnell, New York, Diamond Absolutely Pure Cinnamon.	<i>New Haven.</i> Coe & Jenks, 422 State St.
9432	Colburn Co., The A., Philadelphia, Choicest Java Cinnamon.	G. J. Burt, 894 State St.
9513	Daniels, Cornell & Co., New London, Strictly Pure Cinnamon.	<i>Groton.</i> H. E. Marquidt.
9430	Durkee & Co., E. R., New York, XXX Cinnamon.	<i>New Haven.</i> G. J. Burt, 894 State St.
9229	Farrington & Co., F. R., New York and Boston, Pure Cinnamon.	S. S. Adams, 412 State St.
9511	Leggett & Co., Francis H., New York, Best Cinnamon.	<i>Madison.</i> F. C. Dowd.
9095	Lincoln, Seyms & Co., Hartford, Pure Cinnamon.	<i>Hartford.</i> H. E. Hills & Co., 547 Main St.
9057	Montanye & Co., W. H., New York, Pure Cinnamon.	<i>Greenwich.</i> J. L. Mahoney.
9525	Slade Co., D. & L., Boston, Absolutely Pure Cinnamon.	<i>New Haven.</i> I. B. Chandler, 101 Dixwell Ave.
9449	Sovereign Trading Co., Pure Saigon Cinnamon.	<i>New Britain.</i> Sovereign Trading Co., 282 Main St.
9500	Stickney & Poor, Boston, Absolutely Pure Cassia.	<i>Portland.</i> John Bransfield.
9413	Stickney & Poor, Pure Cinnamon.	<i>Ansonia.</i> D. M. Welch & Son, Main St.
9422	Sultana Spice Mills, New York, A. & P. Cinnamon.	<i>New Haven.</i> Atlantic & Pacific Tea Co., 386 State St.
9474	Union Spice Co., Pure Cinnamon.	<i>Hartford.</i> Union Pacific Tea Co., 174 Asylum St.

SEALED AND LABELED PACKAGES—*Continued.*

Station No.	Price per package, cents.	Ounces in package.	ASH.		Remarks.
			Total.	Insoluble in HCl. (Sand).	
9465	10	3	4.79	....	Not found adulterated.
9419	10	4	5.11	....	do.
9050	10	4	4.86	....	do.
9085	13	4	5.04	....	do.
9222	15	4	5.26	....	do.
9503	15	4	2.70	....	do.
9519	15	4	6.84	....	do.
9497	10	4	3.88	....	do.
9416	10	3	8.02	3.15	do.
9184	15	4	4.70	....	do.
9432	15	3½*	4.93	....	do.
9513	10	4	3.18	....	do.
9430	10	2½	5.15	....	do.
9229	5	4	4.37	....	do.
9511	12	4	4.76	....	Contains ginger.
9095	12	4	5.89	....	Not found adulterated.
9057	12	4	8.40	4.49	do.
9525	9	4	3.71	....	do.
9449	10	4	5.02	....	do.
9500	15	4	4.24	....	do.
9413	10	2½	5.05	....	do.
9422	10	2½	7.15	2.24	do.
9474	10	3	7.27	3.07	do.

* In glass pepper-shaker.

TABLE XXII.—SPICES BOUGHT IN

Station No.	Brand.	Dealer.
9329	Union Spice Co., Pure Cinnamon.	<i>Putnam.</i> Union Pacific Tea Co.
9457	Upson Bros ,Absolutely Pure Cinnamon.	<i>Southington.</i> Upson Bros.
9039	No manufacturer given, Pure Cinnamon.	<i>Bridgeport.</i> The Village Market, Main St.
	<i>Nutmeg.</i>	
7324	Bennett, Simpson & Co., London, Penang Nutmeg.	<i>Hartford.</i> Woodward & Co., 174 Asylum St.
9298	Farrington & Co., F. R., New York, Pure Nutmeg.	<i>New London.</i> J. E. St. John, 265 Bank St.
9484	Hills & Co., Gold Seal Nutmeg.	<i>Hartford.</i> Hills & Co., 372 Asylum St.
9060	Montanye & Co., W. H., New York, Pure Nutmeg.	<i>Greenwich.</i> J. L. Mahoney,
7353	Slade Co., D. & L., Boston, Epicurean Nutmeg.	<i>Willimantic.</i> Frank Larreebee, 16 Church St.
7385	No manufacturer given, Ground Nutmegs.	H. C. Hall, 17 Union St.

SEALED AND LABELED PACKAGES.—*Concluded.*

Station No.	Price per package, centa.	Ounces in package.	Ash.		Remarks.
			Total.	Insoluble in H Cl. (Sand).	
9329	10	3	5.87	...	Not found adulterated.
9457	12	4	4.24	...	Contains ginger.
9039	6	2½	5.44	...	Not found adulterated.
7324	25	4*	7.34	...	do.
9298	10	2	8.46	...	do.
9484	25	2*	6.59	...	do.
9060	28	4	3.47	...	do.
7353	15	2	6.10	...	do.
7385	15	2	6.37	...	do.

* In glass pepper-shaker.

THE CHEMICAL COMPOSITION OF AUTHENTIC SAMPLES OF SPICES AND SPICE ADULTERANTS.

BY A. L. WINTON, A. W. OGDEN, AND W. L. MITCHELL.

The microscope is, without doubt, the most valuable means of detecting adulteration in ground spices, as it furnishes direct ocular evidence and usually discloses the nature of the foreign material present. But since mineral matters and some other spice adulterants do not have very distinctive microscopic characters, it is necessary to resort to chemical analysis for their detection. Furthermore, the results of quantitative chemical determinations often confirm the conclusions reached by microscopic examination and, in cases of adulteration, furnish data for estimating roughly the percentage of foreign matter present.

A knowledge of the composition of the various grades of whole spices on the market is essential for the proper interpretation of analyses of samples of ground spices of unknown origin.

In 1887, Richardson* published a most valuable report on spices and spice adulteration, in which are given full descriptions of the nature and preparation of the various spices, the quantities imported into the United States, the adulterations practiced, and the methods for detecting adulteration. The report also contains analyses of 42 samples of whole spices, ground in the laboratory of the Department of Agriculture, and of numerous samples of ground spices collected in the open market.

Richardson's analyses of whole spices from the American market are, practically, all that have been published up to date, and have been very generally consulted in interpreting results on suspected samples; but grades of some of the spices are now on the market which were not obtainable at the time that Richardson collected his samples, and, furthermore, since his report appeared new methods of analysis have been devised.

* U. S. Dept. of Agr., Div. of Chem., Bull. 13, Part II.

In our examinations of ground spices the need of further analysis of whole spices has been apparent, and during the present year opportunity was presented for this work.

In response to our request, four of the leading spice importers of the country, namely — E. R. Durkee & Co., Francis H. Leggett & Co., and Austin, Nichols & Co., all of New York, and D. & L. Slade Co. of Boston, courteously granted us permission to sample all the goods in their stock, and also offered us their assistance in other ways.

During the months of August and September, 101 samples of pure whole spices were carefully drawn by a representative of the station from original, unbroken, import packages, in warehouses at New York and Boston. Whenever possible, several packages were opened in drawing each sample.

The firms mentioned, through their knowledge of the trade, also secured for us samples of damaged spices and some of the by-products from spices, which are often mixed with ground spices and are generally rated by official analysts as adulterants.

Various samples of ground nut shells, fruit stones, sawdust, and some other materials used as adulterants, were prepared in the station laboratory.

The samples collected may be classified as follows:

Black pepper,	14 samples.
White pepper,	10 "
Cayenne pepper,	8 "
Ginger,	18 "
Ceylon cinnamon,	6 "
Cassia,	21 "
Cassia buds,	2 "
Cloves,	8 "
Allspice,	3 "
Nutmegs,	5 "
Mace,	6 "
Spice by-products and adulterants,	24 "
<hr/>	
Total,	125 samples.

The cereal products used as adulterants have been frequently analyzed in various laboratories, to determine their feeding value, and these analyses we deemed sufficient for our purpose, without collecting and analyzing new samples.

PREPARATION OF SAMPLES.

From one to two pounds of each sample are ground in a steel mill, so as to pass a sieve with round holes $1/25$ inch in diameter. This grinding is usually sufficient, but for the determination of starch in white pepper by the diastase method, it is necessary to reduce to a finer powder in a mortar, as, otherwise, the starch is not completely extracted from the hard grains of endosperm.

METHODS OF ANALYSIS.

Moisture. Two grams are dried at 110° C. to constant weight. From the loss in weight thus sustained is subtracted the amount of volatile ether extract, the difference being moisture.

Total Ash. Two grams are incinerated in a muffle furnace, at a heat below redness.

Ash Soluble in Water. The ash prepared as above is boiled with 50 cc. of water and the insoluble portion collected on a Gooch crucible, washed with hot water, dried, ignited, and weighed. The percentage of insoluble ash thus determined, subtracted from the percentage of total ash, leaves the percentage of water-soluble ash.

Ash Insoluble in Hydrochloric Acid, or "Sand." Two grams of the incinerated material are boiled with 25 cc. of 10 per cent. hydrochloric acid and the insoluble matter collected in a Gooch crucible, washed with hot water, ignited, and weighed.

Lime. A weighed portion is incinerated and the ash dissolved in boiling hydrochloric acid. If soluble silica is present, it is separated in the usual manner. The acid solution, nearly neutralized with ammonium hydrate, is heated to about, but not above 50° C. 3 cc. of acetic acid and ammonium acetate in sufficient quantity are added and the solution is vigorously stirred. When the precipitate of iron phosphate, or of iron phosphate and basic acetate, has settled, it is filtered and washed with water containing a little ammonium acetate. To the filtrate, without neutralizing the acetic acid, ammonium oxalate is added and the precipitate of calcium oxalate collected on a filter, converted into oxide by ignition and weighed.

Volatile and Non-Volatile Ether Extract. The method is that described by Richardson.* Two grams of the ground material are extracted for 20 hours in a Johnson extractor† with absolute ether. The ethereal solution is transferred to a tared capsule and the ether allowed to evaporate at the room temperature. After standing 18 hours over sulphuric acid, the total ether extract is weighed. The extract is then heated, first at 100° for 6 hours and then at 110° , until the weight becomes constant, the loss being the volatile oil; the residue, the non-volatile ether extract.

Absolutely complete extraction of spices, even after treatment with ether for several days, is hardly possible, but the results which follow, Table XXIII, show that, for all practical purposes, extraction for 20 hours is sufficient.

* U. S. Dept. Agr., Div. Chem., Bull. 13, Part II, 165.

† Amer. Jour. Sci., March, 1877, 196.

TABLE XXIII. ETHER-EXTRACT FROM PURE SPICES.

	AVERAGE PER CENT. OF ETHER-EXTRACT REMOVED.		
	During 1st 10 hours extraction.	Between 10th and 20th hours of extraction.	Between 20th and 30th hours of extraction.
Allspice. Three samples,	9.28	0.28	0.18
Black Pepper. Eight samples,	9.40	0.14	0.08
Cassia. Three Samples,	5.87	0.27	0.10
Cassia Buds. Two samples,	9.37	0.33	0.14
Cayenne. Eight samples,	20.59	0.43	0.20
Cloves. Eight samples,	25.18	0.25	0.16
Clove Stems. Two samples,	8.56	0.16	0.10
Cinnamon. Three samples,	2.63	0.26	0.19
Ginger. One sample,	4.32	0.18	0.11
Mace. Five samples,	31.53	0.25	0.21
Nutmeg. Two samples,	39.08	0.19	0.11

Alcohol Extract. — Two grams of material are placed in a 100 cc. flask, which is filled to the mark with ninety-five per cent. alcohol (sp. gr. 0.817). The flask is stoppered and allowed to stand twenty-four hours, being shaken every thirty minutes during the first eight hours. The extract is then filtered through a dry filter, and 50 cc. are evaporated to dryness in a flat-bottomed aluminium dish on a water bath, and heated to constant weight at 110° C. The result is practically the same when the time of extraction is forty-eight instead of twenty-four hours.

It is not claimed that this method extracts all matter soluble in alcohol; in fact, the residues separated from the solutions by filtration, when treated for twenty-four hours longer with a fresh portion of ninety-six per cent. alcohol, yield small additional amounts of extract; but the method gives nearly the full amount of extract and the results are concordant; whereas, extraction in a Soxhlet apparatus, if continued until no more extract is removed, is almost an interminable operation, and, as it is difficult to keep the strength and temperature of the extracting alcohol constant, does not give satisfactory results.

Copper-Reducing Matters by Direct Inversion. — Four grams are extracted with ether and washed on a filter that will completely retain the smallest starch granules,* with 150 cc. of ten per cent. alcohol.† Weak alcohol is employed instead of water, because, as pointed out by Lindsey, it is not so liable to carry starch granules through the paper. The residue is transferred to a 500 cc. flask, with 200 cc. of water; 20 cc. of hydrochloric acid (sp. gr. 1.125) are added and

* Schleicher and Schüll's No. 589 blue ribbon washed filters were found satisfactory.

† As Batavia cassia forms with water or dilute alcohol a glutinous mass which clogs the filter, it is not possible to wash samples of this cassia with either liquid previous to inversion, and, for the sake of uniformity, this treatment is also omitted in the determinations made on the other varieties of cassia, as well as on cassia buds and cinnamon.

the whole heated on a boiling water bath for three hours (Sachsse's Method *). After cooling, the solution is nearly, but not quite, neutralized with sodium hydrate solution, made up to 500 cc. and filtered through a dry paper. Reducing matters are determined by Allihn's method,† as follows :

Thirty cc. of a solution containing 173 grams of Rochelle salt and 125 grams of caustic potash in 500 cc. of water, and 30 cc. of a solution of 34.69 grams of pure crystallized copper sulphate in 500 cc. of water are mixed in a beaker of 200 cc. capacity and the mixture heated to boiling. To the boiling liquid, without delay, are added 25 cc. of the solution to be examined, and the heating further continued until boiling begins again. After the reduced copper suboxide has settled it is collected on a Gooch crucible, dried at a moderate heat, and finally, heated *carefully* for three to five minutes at dull redness, care being taken to avoid a bright red heat and to allow access of sufficient air to complete the oxidation to copper oxide. After weighing, the heating should, in all cases, be repeated, to make certain that the oxidation is complete.

From the weight of copper oxide is calculated the weight of metallic copper, the factor .7986 being used, and the corresponding amount of dextrose is found in Allihn's tables. From the weight of dextrose, that of starch is calculated by using the factor 0.9.

In the preparation of asbestos pulp for use in the Gooch crucible, woolly asbestos is cut into small pieces, boiled with hydrochloric acid and washed free from acid and fine particles on a sieve with $\frac{1}{8}$ inch meshes. This asbestos, when packed in the crucibles with the aid of a blunt glass rod, retains completely the finely divided copper suboxide, which is not true of the long fiber variety usually employed in filtering coarser precipitates.

To test the accuracy of the oxidation method, six precipitates which had been weighed as oxide were reduced in hydrogen and weighed as metallic copper.‡ The following are the results :

Station No.	Material.	Cu.		
		CuO.	Calculated from CuO.	Obtained by reduction.
		Gram.	Gram.	Gram.
9688	Decorticated white pepper,	0.3450	0.2755	0.2755
9643	Siam white pepper, . . . . .	.3170	.2532	.2531
9644	Singapore white pepper, . . . . .	.3039	.2428	.2433
9682	Pin-head pepper, . . . . .	.1600	.1278	.1281
9684	Pepper shells (hulls and dust), . . . . .	.1185	.0946	.0948
9690	Pepper shells (hulls), . . . . .	.0600	.0479	.0480

* Chem. Centralbl., 1877, 732. This Station Rep., 1887, 132.

† Jour. Prakt. Chem., 22, 52. This Station Rep., 1887, 129.

‡ Compare Bartlett, Maine Ag. Ex. Sta. Rep., 1888, 207.

Starch by Diastase Method. — The method employed, except in minor details, is that described by Maercker.*

Four grams of the finely ground material are extracted with ether and ten per cent. alcohol, as described in the preceding section. The wet residue is rubbed up thoroughly in a mortar, washed into a beaker with 100 cc. of water, and made into a paste by boiling for thirty minutes. To prevent sticking to the bottom of the beaker and burning, the heating is performed on an asbestos plate and the liquid is constantly stirred with a rod. The water lost by evaporation is replaced and the beaker immersed in a water bath kept at from 55° to 60° C. When the liquid has cooled to the temperature of the bath, 10 cc. of freshly prepared malt extract† are added and the mixture digested for one hour, with occasional stirring. It is then boiled a second time for fifteen minutes, cooled, and digested, as before, with another portion of 10 cc. of malt extract. After heating to boiling the third time, the liquid is made up to 250 cc. in a graduated flask, filtered through dry paper and 200 cc. of the filtrate removed to a 500 cc. flask. The inversion with acid and determination of the reducing power is conducted as has been described, making a correction for the copper reduced by the added malt extract, which is determined by blank analyses. The residue after the malt digestion, when examined microscopically, should be entirely free from starch.

Cayenne pepper, mustard, and certain other materials, which are practically free from starch — as is shown by the microscope — when treated by the method just described, yield very little or no copper-reducing matter. This treatment is, therefore, without effect on the cellulose, pentosans, or other matters in the spices named, although they yield copper reducing material on treatment with acid.

On the other hand, in decorticated white pepper and Jamaica ginger, which contain little besides starch that is affected by acid, practically the same results are obtained by the diastase method as by direct inversion with acids.

This determination of starch is very valuable as a means of detecting starchy adulterants in spices normally free from starch, and non-starchy adulterants in spices which contain starch.

Crude Fiber is determined by the method of the Association of Official Agricultural Chemists,‡ with slight modifications:

The residue from the determination of ether extract is placed in a 500 cc. Erlenmeyer flask and 200 cc. of boiling 1.25 per cent. sulphuric acid are added. The flask is loosely covered and the liquid heated at once to gentle boiling. The boiling is continued thirty minutes. The solution is filtered on a paper, washed with hot water, and rinsed back into the same flask, with 200 cc. of boiling 1.25 per cent. solution of sodium hydrate nearly free from carbonate. After boiling as before for thirty minutes, the fiber is collected on a weighed paper, thoroughly

* Handbuch der Spiritusfabrikation, 7th Ed., 1898, 109. See also Wiley, Principles and Practice of Agricultural Analysis, 1897, Vol. III, 198.

† Prepared by digesting for two or three hours 100 grams of powdered malt with 1000 cc. of water and filtering.

‡ U. S. Dept. of Agr., Div. Chem., Bull. 46, 63.

washed with hot water, and finally washed with a little alcohol and ether, dried to constant weight at 100° C. and weighed.

The amount of ash in the fiber is determined by incineration, and deducted from the total weight.

Nitrogen by the Kjeldahl Method.— Nitrogen is determined in all the spices, except black and white pepper, by the usual Kjeldahl method.*

Nitrogen by the Gunning-Arnold method.— As nitrogen cannot be accurately determined in black and white pepper by the Kjeldahl method, owing to the presence of piperine, the Gunning-Arnold method is used to determine nitrogen, both in pepper and in the ether extract from the pepper.†

One gram of the material is mixed in a 600 cc. Jena flask with one gram of cupric sulphate, one gram of red oxide of mercury, fifteen to eighteen grams of potassium sulphate, and 25 cc. of sulphuric acid. After heating gently without shaking until frothing ceases, the mixture is boiled from three to four hours. When nearly cool, about 300 cc. of water, 50 cc. of potassium sulphide solution and sodium hydrate solution to alkaline reaction are added and the ammonia is distilled and titrated as usual.

The following percentages of nitrogen were obtained on chemically pure piperine :—

Gunning-Arnold method,	4.77, 4.77, 4.79, and 4.83 per cent.
Absolute method,	4.92 per cent.
Theory,	4.91 " "

By the Kjeldahl and by the Gunning method, percentages ranging from 2.06 to 3.8 were obtained.

The determination by the absolute method was made by Mr. Campbell.

Nitrogen in the Ether Extract.— Ten grams of material are extracted for twenty hours in a Johnson extractor, the extract being collected in a weighed Jena flask of about 250 cc. capacity. The ether is evaporated and the flask with contents is heated, first at 100°, and, finally, to constant weight at 110°. Nitrogen is determined in the weighed extract by the Gunning-Arnold method, as already described.

Cold Water Extract.— Four grams of the material are placed in a 200 cc. flask and water added to the mark. The flask is tightly stoppered and shaken at half-hour intervals during eight hours, after which it is allowed to stand sixteen hours without shaking. A 50 cc. portion of the filtered solution is transferred to a tared aluminium dish and evaporated to dryness on a water bath. The residue is dried to constant weight at 100° C. in a drying oven, two hours' heating being usually sufficient.

This method is much more easily carried out and gives more concordant and somewhat higher results than extraction on a filter, with the same volume of water added in successive portions. Complete extraction on a filter was found impossible.

* U. S. Dept. of Agr., Div. Chem., Bull. 46, 16.

† Ztschr. Anal. Chem., 31, 525.

*Tannin Equivalent.**—Two grams of material in a paper cylinder are extracted twenty hours with Squibbs' absolute ether. The residue is boiled for two hours with 300 cc. water, cooled, made up to 500 cc., and filtered.

Twenty-five cc. of the filtrate are measured into a flask of about 1,200 cc. capacity; 20 cc. of indigo solution and 750 cc. distilled water are added and standard potassium permanganate run in at the rate of one or two drops a second, with constant shaking, until a bright golden yellow is obtained.

The reducing power of 20 cc. of indigo solution is determined in exactly the same manner.

The number of cc. of permanganate required to oxidize the tannin and indigo together, less the amount necessary to oxidize 20 cc. indigo solution alone, gives the number of cc. equivalent to the tannin present.

Standard potassium permanganate is prepared by dissolving 1.333 grams of the pure salt in 1,000 cc. of water. It is standardized by the titration of 10 cc. of decinormal oxalic acid (6.3 grams of pure crystallized acid in 1,000 cc.) which have previously been diluted to 500 cc., heated to 60° C., and mixed with 20 cc. of dilute sulphuric acid (1.3). The permanganate is added slowly, with constant stirring, until a pink color appears.

Indigo solution must be made from sodium sulphindigotate of good quality, otherwise the titration will not be sharp.† Six grams of the salt are dissolved in 500 cc. of water, with the aid of heat, cooled, mixed with 50 cc. of concentrated sulphuric acid, made up to one liter and filtered.

Ten cc. of decinormal oxalic acid solution are equivalent to 0.06235 grams of quercitannic acid, or 0.008 grams of "oxygen absorbed."

The value of the method for the examination of cloves is apparent when the "tannin equivalent" of pure cloves is compared with that of the common adulterants of cloves.

Determinations of tannin equivalent were also made on a few samples of other spices, but the results, as will be seen from the following table, are too low to be of much diagnostic value:

Station No.	Material.	Oxygen Equivalent.	Calculated as Quercitannic Acid.
9631	Cassia,	0.50	3.90
9640	Cinnamon,	0.98	7.80
9618	Ginger,	0.03	.26
9677	Mace,	0.16	1.30
9617	Nutmegs,	0.33	2.60
9610	Red Pepper,	0.13	1.04
9654	Red Pepper,	0.33	2.60
9714	Black Pepper,	0.33	2.60
9690	Pepper Shells,	0.43	3.38
9692	Long Pepper,	0.13	1.04
9609	Cassia Buds,	1.13	8.84

* See U. S. Dept. Ag., Div. Chem., Bull. 13, Part II, 167. Also Allen, Commercial Organic Analysis, 1889, Vol. III, Part I, p. 109 *et seq.*

† The indigocarmin of G. Grueber & Co., Leipsic, is adapted for the purpose.

NOTES ON THE SAMPLES EXAMINED.

Black Pepper, Pepper By-products and Adulterants.

Singapore black pepper, it is stated, is dried over fires in the gambier plantations, and has, in consequence, a strong smoky odor. The berries are hard and perfect. The other varieties of black pepper are usually sun dried.

Singapore, Tellicherry, and Lampong are at present valued in the order stated, although there is but little difference in price.

Acheen, Sumatra, or Penang is of poorer quality and contains more or less empty berries, many of which are broken during transportation. Formerly there were two grades, the East Coast and the West Coast, the latter being considered the better, but the pepper from Sumatra is now graded by the London Produce Brokers' Association as follows :

Class A. One imperial gallon should weigh at least four pounds thirteen ounces (481 grams per liter).

Class B. One imperial gallon should weigh at least four pounds five ounces (431 grams per liter).

Class C. One imperial gallon should weigh at least three pounds thirteen ounces (381 grams per liter).

Class D. One imperial gallon should weigh at least three pounds nine ounces (356 grams per liter).

Class A is the same as West Coast Sumatra, and some lots run over five pounds to the gallon. None of the grades should contain over three per cent. of "dust," which term includes stalks, stone, clay, and other foreign matter.

Messrs. E. R. Durkee & Co. supplied the results of actual tests of the samples procured from them, which are as follows :

No. 9646.* Four pounds fourteen ounces per gallon (488 grams per liter), three and one-half to four per cent. dust.

No. 9647. Four pounds per gallon (400 grams per liter), four per cent. dust.

No. 9648. Three pounds ten ounces per gallon (362 grams per liter).

No. 9682, pin-head pepper, is a mixture of small pepper corns with a large amount of shells.

* The numbers refer to samples whose analyses are given on pp. 198 and 199.

Pepper shells is the trade name for a mixture of hulls and dust obtained as a by-product in the preparation of white pepper. Nos. 9689 and 9684 contain not only shells, but a large amount of powdered material, and represent fairly the goods frequently sold as pepper shells. No. 9690 consists almost entirely of hulls, such as are always present in small amount in the lower grades of Acheen.

Long pepper, the fruit of *Piper longum*, is occasionally used as an adulterant for black pepper. One sample, No. 9692, was analyzed.

White Pepper.

Decorticated white pepper (Nos. 9641 and 9688) consists of hard, smooth kernels which, for the most part, are entirely free from the seed coats. Singapore and Siam white pepper are at present of about the same quality and cost. The samples of Penang drawn by us are all coated with a dirty brown material consisting chiefly of carbonate of lime.

Cayenne Pepper.

The samples of Japan cayenne or chillies are entirely free from stems and calyxes. The pods are about 2 cm. long and 0.5 cm. broad at the broadest part, and of a most brilliant red color.

Zanzibar cayenne is one of the best varieties used for grinding, although at present the quality is rather poor. In the samples examined the slender pods vary in length from 0.5 to 2.0 cm., and are of a dull red or brown color. The stems and calyxes are present, but usually detached from the pods.

Capsicums, or "Bombay peppers," are a low grade of chillies which are now said to come from the vicinity of the river Niger, in Africa. In the samples examined, which are free from stems and calyxes, the brown or yellow brown pods are 2 to 3 cm. long and nearly 1 cm. broad.

Ginger and Ginger By-products.

Two grades of Jamaica ginger come into our market, the "scraped" or "unbleached" and the "bleached" or "limed." The bleached root appears to be the same product as the unbleached, except for a coating of chalk which serves as a protection against the destructive drugstore beetle and other insects.

Cochin ginger (also called Borneo ginger) is of several grades. No. 9670 is stated to be rough washed, but not bleached. No. 9678 has been "cut" (trimmed), scraped, and limed. The samples graded A, B, C, are of light color and fine appearance, but neither scraped nor limed. The roots of D Cochin are not as thick as the A, B, C, and are darker in color.

Both samples of Japan ginger, Nos. 9656 and 9725, consist of short, thick pieces of root coated with lime, and resemble the cut and scraped Cochin, No. 9678.

African ginger (also known as Sierra Leone) and Calcutta ginger (also known as East India) are both dark-colored, unattractive products. Of these the African is much the better in quality, although at present it is sold for about the same price as the Calcutta.

No. 9681, rejections from D Cochin, and No. 9693, ginger cuttings or clippings, should be considered as a ginger by-product and not as ginger.

One of the samples of exhausted ginger, No. 9727, is stated to have come from an English ginger-ale works; the other, No. 9368, is from an extract factory.

Cinnamon, Cassia, and Cassia Buds.

Ceylon, or true cinnamon, is graded according to the diameter of the composite quills, No. 1 extra being the smallest. It is now seldom used in the United States as a spice, the so-called ground cinnamon being prepared from cassia bark or buds.

Saigon cassia, the best grade of cassia, varies in size from pieces scarcely thicker than a sheet of writing paper to coarse bark, one-eighth inch or more in thickness. It is put up in bundles weighing three to four pounds, each consisting entirely of thick,

thin, or medium thickness bark. Several bundles of different sized bark are packed in the same mat. The thin bark is considered the strongest. Two samples of broken Saigon (Nos. 9636 and 9707) are of good quality, but No. 9698, graded as No. 2, is inferior, containing pieces of bark one-quarter inch in thickness.

Batavia cassia comes in two grades, No. 1 and No. 2, the latter, which is also known as broken Batavia or short stick, is not so well scraped as No. 1 and comes in shorter pieces.

Whole China cassia is packed in mats containing two bundles of about two pounds each. The outer pieces in the bundles are a foot or more long, but the interior contains chips, and often, more or less dirt. The frosts of some years ago killed many of the trees in China, and it has been stated that the bark of the dead trees is now put on the market. The sample of broken China cassia, No. 9737, owing to the dirt it contains, is entirely unfit for consumption. In order to accurately arrive at the composition, a bale of sixty pounds was separated into two parts, by sifting through a one-quarter inch mesh, and each part was separately analyzed.

One hundred of the cassia buds from No. 9609 weigh 6.15 grams, and from No. 9665 weigh 6.03 grams.

Cloves and Clove Stems.

No particulars other than are given in the table were learned.

Allspice.

No two of the samples are alike in appearance, and it is not remarkable that the analyses show a wide variation in composition.

Nutmegs.

True nutmegs are the dried seed kernels of *Myristica fragrans*, Houttuyn. Of the better grades, the brown (*i. e.* unlimed) Penang nutmegs are sold to some extent in the United States, but not so commonly as the limed kernels from Banda and Singapore.

The Singapore nutmegs examined (Nos. 9617, 9664, and 9719) are from 2.2 to 2.8 cm. long, and from 1.7 to 2.1 cm. broad.

The Padang nutmegs (No. 9673) are deeply wrinkled on the surface and extremely variable in form and size, ranging in length from 2 to 2.9 cm., and in breadth from 1.5 to 2.1 cm.

The so-called Macassar nutmegs, which are probably the same as those known in Europe as Papua or long nutmegs (the seed kernels of *M. argentea*, Warb.), are inferior to the true nutmegs. In the sample examined the kernels are from 2.6 to 3.6 cm. long, and from 1.6 to 2.1 cm. broad.

The sample of grinding nutmegs, No. 9696, consists of abortive and insect-eaten kernels, with some nutmeg shells, and is entirely unfit for consumption. The starchy portion of the insect-eaten kernels has been entirely devoured, leaving only the resinous veins in the interior. On the surface are holes through which the insect emerged. Many of these nutmegs can be readily crushed between the fingers.

Mace.

The true or sweet mace (the seed mantle or arillus of *Myristica fragrans*, Houttuyn) which comes into this country is designated Banda, Penang, Singapore, and Batavia, or Padang, according to its origin. As the product from any of these localities may be good or bad, it is customary to value mace more by its appearance than by its place of growth.

The sample of Banda mace, No. 9619, and the two samples of No. 1 Penang mace, Nos. 9662 and 9717, are of good quality and alike in appearance. No. 9677 (No. 2 Penang) is somewhat inferior.

The "grinding mace," No. 9694, is evidently damaged.

Macassar or wild mace, the arillus of *Myristica argentea*, Warb., has a strong wintergreen flavor, but is considered inferior to the varieties of true or sweet mace. The sample analyzed, No. 9675, contains a few shells of the nutmeg, in addition to the arillus.

Bombay mace, from *Myristica Malabarica*, Lamark, must be regarded as an adulterant. The sample examined, No. 9676, has no value whatever as a spice.

WHOLESALE QUOTATIONS OF SPICES, SEPT. 12, 1898.

Cassia, Batavia, No. 1,	Per lb., 17 @ 18
broken,	13 @ 15
Canton, matted rolls,	8¼ @ 9
broken,	6¼ @ 7½
Saigon, rolls,	48 @ 52
broken,	37 @ 38
Buds,	23½ @ 25
Cloves, Amboyna,	10¼ @ 12
Zanzibar,	8¼ @ 9
stems,	— @ 4½
Ginger, African,	4¼ @ 5
Calcutta,	4½ @ 5
Cochin, A, B, C,	6¼ @ 6¾
D,	5 @ 5½
Jamaica, bleached,	19 @ 20
unbleached,	17 @ 20
Mace, Banda,	45 @ 48
Batavia,	33½ @ 38
Penang,	43 @ 45
Nutmegs, 110's,	32 @ 32½
Pepper, black, Acheen,	9½ @ 9½
Singapore,	9½ @ 9¾
West Coast Sumatra,	9½ @ —
white, Penang,	16¼ @ 16¾
Singapore,	18 @ 18¼
red, capsicums,	7¼ @ 8½
Zanzibar,	11 @ 12
Pimento, Jamaica, prime,	9¾ @ 10½

TABLE XXIV. BLACK PEPPER, WHITE PEPPER,

Station No.		Importer.	Weight of 1 litre in grams.
<i>Black Pepper:</i>			
9712	Singapore,	Austin, Nichols & Co., New York,	452.
9649	"	E. R. Durkee & Co., New York,	474.
9614	"	D. & L. Slade Co., Boston,	493.
9615	"	"	472.
9616	"	"	489.
	average,		476.
9713	Tellicherry,	Austin, Nichols & Co., New York,	535.
9650	"	E. R. Durkee & Co., New York,	561.
	average,		548.
9645	Lampong,	E. R. Durkee & Co., New York,	493.
9685	"	Francis H. Leggett & Co., New York,	530.
	average,		511.
9646	Acheen, Class A,	E. R. Durkee & Co., New York,	432.
9647	Acheen, Class B,	"	407.
9648	Acheen, Class C,	"	345.
9683	"	Francis H. Leggett & Co., New York,	316.
9714	Acheen, Class not given,	Austin, Nichols & Co., New York,	301.
	Acheen, average,		360.
	All analyses. {	Maximum,	561.
		Minimum,	301.
		Average,	
<i>Pepper By-products and Adulterants:</i>			
9682	Pinhead. Siftings from Acheen, Class C,		
9690	Pepper Shells (hulls only),		
9684	Pepper Shells (hulls and dust),		
9689	"		
9692	Long Pepper,		
9732	Buckwheat hulls,		
<i>White Pepper:</i>			
9641	Decorticated,	E. R. Durkee & Co., New York,	761.
9688	"	Francis H. Leggett & Co., New York,	785.
	average,		773.
9716	Singapore,	Austin, Nichols & Co., New York,	618.
9644	"	E. R. Durkee & Co., New York,	599.
	average,		608.
9671	Siam,	Francis H. Leggett & Co., New York,	693.
9643	"	E. R. Durkee & Co., New York,	678.
9611	"	D. & L. Slade Co., Boston,	694.
	average,		688.
9642	Penang,	E. R. Durkee & Co., New York,	679.
9672	"	Francis H. Leggett & Co., New York,	673.
9715	"	Austin, Nichols & Co., New York,	666.
	average,		673.
	All analyses. {	Maximum,	785.
		Minimum,	599.
		Average,	

BY-PRODUCTS, AND ADULTERANTS.

Weight of 100 corns, in grams.	Moisture.	ASH.		ETHER EXTRACT.			Alcohol extract.	Reducing matters by direct inversion cal- culated as starch.	Starch by diastase method.	Crude fiber.	Total N. less N. in non-volatile ether extract $\times 6\frac{1}{2}\%$.	NITROGEN.		Parts of N. in 100 parts non-volatile ether extract.
		Total.	Soluble in water.	Insoluble in HCl.	Volatile.	Non-volatile.						Total.	In non-volatile ether extract.	
4.06	12.43	3.68	2.26	0.15	1.10	7.86	9.35	41.36	37.50	11.67	12.31	2.28	0.31	3.92
5.26	11.88	3.09	1.75	0.13	1.08	7.92	8.95	43.47	36.81	10.76	13.81	2.53	0.32	4.05
5.46	11.47	3.54	2.04	0.07	1.08	7.36	8.77	43.26	39.32	10.84	12.19	2.25	0.30	4.02
5.20	12.07	3.63	2.25	0.12	1.04	7.71	8.75	43.02	39.24	11.20	12.13	2.25	0.31	4.00
4.49	12.16	3.53	2.22	0.12	0.99	7.75	8.62	42.89	39.66	10.75	13.12	2.41	0.31	3.95
4.89	12.00	3.49	2.10	0.12	1.06	7.73	8.89	42.80	38.51	11.04	12.71	2.36	0.31	3.99
4.77	11.86	4.28	2.75	0.00	0.65	6.86	8.47	41.80	37.01	12.23	11.88	2.17	0.27	3.90
4.13	11.27	4.14	2.75	0.02	1.02	7.02	9.14	41.55	37.01	12.17	11.70	2.14	0.27	3.88
4.45	11.56	4.21	2.75	0.01	0.83	6.94	8.80	41.67	37.01	12.20	11.79	2.15	0.27	3.89
3.43	10.63	6.52	2.16	1.19	1.11	8.67	9.49	37.09	33.41	12.72	11.37	2.15	0.33	3.82
3.55	12.17	4.86	2.21	0.48	1.23	9.05	9.95	41.42	37.59	11.57	10.50	2.03	0.35	3.85
3.49	11.40	5.69	2.18	0.83	1.17	8.86	9.72	39.25	35.50	12.14	10.93	2.09	0.34	3.83
3.44	12.09	5.04	2.78	0.48	1.09	9.17	10.04	38.17	33.30	13.07	10.88	2.11	0.37	4.06
2.66	12.05	6.15	3.04	1.15	1.15	9.03	9.95	36.40	33.08	14.09	11.75	2.25	0.37	4.06
2.67	11.84	6.10	3.01	1.04	1.28	9.47	10.28	31.41	26.81	16.40	12.25	2.34	0.38	4.01
2.12	12.33	6.35	3.19	1.00	1.60	9.64	11.07	28.15	22.05	18.25	12.56	2.39	0.38	3.99
2.18	12.33	5.73	3.20	0.64	1.58	10.37	11.86	30.82	25.39	17.08	12.25	2.36	0.40	3.90
2.61	12.31	5.87	3.04	0.86	1.34	9.54	10.64	32.99	28.13	15.78	11.94	2.29	0.38	4.00
5.46	12.95	6.52	3.2	1.19	1.60	10.37	11.86	43.47	39.66	18.25	13.81	2.53	0.40	4.06
2.12	10.63	3.09	1.75	0.00	0.65	6.86	8.47	28.15	22.05	10.75	10.50	2.03	0.27	3.82
....	11.96	4.76	2.54	0.47	1.14	8.42	9.62	38.63	34.15	13.06	12.05	2.26	0.33	3.96
....	10.95	8.25	2.34	1.74	1.26	8.24	9.66	29.01	25.03	17.51	11.25	2.10	0.30	3.65
...	10.57	11.91	3.20	4.70	0.68	3.04	4.00	11.43	2.30	32.15	14.19	2.36	0.09	2.91
....	10.52	10.31	2.28	2.88	1.06	4.77	5.71	21.69	15.30	23.61	12.94	2.21	0.14	3.01
....	10.66	10.25	2.90	2.63	1.02	4.97	6.30	20.99	14.12	23.27	12.31	2.12	0.15	2.94
....	9.47	5.92	4.20	0.22	1.55	6.01	8.67	42.88	39.55	5.76	12.25	2.18	0.22	3.34
....	7.63	1.84	1.24	0.00	0.07	0.38	2.17	20.51	1.46	43.76	3.06	0.49	....	....
2.77	12.72	1.03	0.44	0.00	0.49	7.26	7.71	64.79	63.60	0.54	11.13	2.10	0.32	4.40
2.78	13.07	1.10	0.51	0.02	0.63	7.21	7.95	64.92	62.73	0.66	10.94	2.07	0.32	4.45
2.77	12.89	1.06	0.47	0.01	0.56	7.24	7.83	64.85	63.16	0.60	11.03	2.08	0.32	4.42
4.35	13.12	1.52	0.33	0.10	0.95	7.94	8.35	57.00	54.67	4.25	11.19	2.13	0.34	4.35
4.47	13.82	1.14	0.34	0.09	0.90	7.85	8.55	56.43	53.11	3.95	11.06	2.09	0.34	4.32
4.41	13.47	1.33	0.33	0.09	0.92	7.89	8.45	56.71	53.89	4.10	11.06	2.11	0.34	4.33
4.81	13.65	1.26	0.39	0.04	0.58	6.81	7.53	58.90	56.33	3.55	10.88	2.03	0.29	4.27
5.00	12.77	1.71	0.46	0.20	0.83	6.54	7.35	59.10	56.10	3.49	10.75	2.01	0.29	4.36
4.49	14.47	1.43	0.28	0.07	0.67	6.58	7.19	59.04	56.10	3.52	10.44	1.95	0.28	4.28
4.77	13.63	1.47	0.38	0.10	0.69	6.64	7.36	59.01	56.18	3.52	10.69	2.00	0.29	4.30
5.38	13.40	2.73	0.52	0.11	0.62	6.36	7.34	57.35	54.74	3.78	10.94	2.03	0.28	4.33
5.18	14.19	2.96	0.62	0.18	0.76	6.34	7.26	57.24	54.02	3.70	10.82	1.99	0.26	4.05
5.02	13.45	2.82	0.80	0.17	0.89	6.26	7.36	56.94	53.26	3.91	10.88	2.01	0.27	4.32
5.19	13.68	2.84	0.65	0.15	0.76	6.32	7.32	57.17	54.01	3.80	10.88	2.01	0.27	4.23
5.38	14.47	2.96	0.80	0.20	0.95	7.94	8.55	64.92	63.60	4.25	11.19	2.13	0.34	4.45
2.77	12.72	1.03	0.28	0.00	0.49	6.26	7.19	56.43	53.11	0.54	10.44	1.95	0.26	4.05
....	13.47	1.77	0.47	0.10	0.73	6.91	7.66	59.17	56.47	3.14	10.89	2.04	0.30	4.31

TABLE XXV.—

Station No.		Importer.	Weight of 100 pods in grams.
9720	Japan,	Austin, Nichols & Co., New York, . .	6.82
9679	"	Francis H. Leggett & Co., New York, .	6.70
9610	"	D. & L. Slade Co., Boston,	7.14
	average, . . . . .	.....	6.89
9721	Zanzibar,	Austin, Nichols & Co., New York, . .	4.27
9654	"	E. R. Durkee & Co., New York, . . .	4.40
9626	"	D. & L. Slade Co., Boston,	4.50
	average, . . . . .	.....	4.39
9653	Capsicums,	E. R. Durkee & Co., New York, . . .	21.96
9695	"	Austin, Nichols & Co., New York, . .	23.31
	average, . . . . .	.....	22.63
All analyses, { Maximum,			23.31
{ Minimum,			4.27
Average, . . . . .			.....

CAYENNE PEPPER.

Moisture.	ASH.			ETHER EXTRACT.		Alcohol extract.	Reducing matters by direct inversion calculated as starch.	Starch by diastase method.	Crude fiber.	Nitrogen %.	Total nitrogen.
	Total.	Soluble in water.	Insoluble in HCl.	Volatile.	Non-volatile.						
5.78	5.80	4.54	0.14	1.02	20.89	25.46	8.19	1.46	21.44	13.75	2.20
5.61	5.96	4.93	0.05	1.16	21.15	23.77	7.15	1.35	21.95	14.63	2.34
6.45	5.18	4.17	0.08	0.78	21.81	23.19	7.65	0.80	21.65	13.44	2.15
5.95	5.65	4.55	0.09	0.99	21.28	24.11	7.66	1.20	21.68	13.94	2.23
4.86	5.43	3.40	0.18	1.99	18.37	21.52	8.91	0.84	24.91	13.31	2.13
6.87	5.61	3.36	0.19	1.24	17.17	23.22	9.31	0.84	24.34	13.94	2.23
3.67	5.24	3.30	0.11	2.57	19.11	25.64	9.04	0.90	23.44	13.31	2.13
5.13	5.43	3.35	0.16	1.93	18.22	23.46	9.09	0.86	24.23	13.52	2.16
7.08	5.15	4.13	0.20	0.73	21.16	24.42	8.95	0.84	20.69	13.56	2.17
5.48	5.08	4.02	0.23	1.34	21.56	27.61	8.55	1.06	20.35	13.38	2.14
6.28	5.11	4.07	0.21	1.03	21.36	26.01	8.75	0.95	20.52	13.47	2.15
7.08	5.96	4.93	0.23	2.57	21.81	27.61	9.31	1.46	24.91	14.63	2.34
3.67	5.08	3.30	0.05	0.73	17.17	21.52	7.15	0.80	20.35	13.31	2.13
5.73	5.43	3.98	0.15	1.35	20.15	24.35	8.47	1.01	22.35	13.67	2.18

TABLE XXVI.—GINGER AND

Station No.		Importer.	Moisture.
<i>Ginger.</i>			
9618	Jamaica, bleached (limed),	D. & L. Slade Co., Boston,	10.56
9723	" " " average	Austin, Nichols & Co., New York,	10.57
9724	Jamaica, unbleached,	Austin, Nichols & Co., New York,	11.72
9655	" " " "	E. R. Durkee & Co., New York,	10.27
9620	" " " average,	D. & L. Slade Co., Boston,	11.67
9678	Cochin, cut and scraped (limed),	Francis H. Leggett & Co., New York,	9.97
9670	Cochin, rough washed,	" " " "	9.96
9624	Cochin, A, B, C,	D. & L. Slade Co., Boston,	10.54
9657	" " " average,	E. R. Durkee & Co., New York,	10.33
9660	Cochin, D,	E. R. Durkee & Co., New York,	9.91
9697	" " " average,	Austin, Nichols & Co., New York,	8.71
9656	Japan (limed),	E. R. Durkee & Co., New York,	11.13
9725	" " " average,	Austin, Nichols & Co., New York,	11.65
9722	African,	Austin, Nichols & Co., New York,	9.99
9659	" " " "	E. R. Durkee & Co., New York,	9.89
9623	" " " average,	D. & L. Slade Co., Boston,	10.03
9658	Calcutta or East India,	E. R. Durkee & Co., New York,	10.19
9621	" " " " average,	D. & L. Slade Co., Boston,	10.86
All analyses, { Maximum,			11.72
{ Minimum,			8.71
{ Average,			10.44
<i>Ginger By-Products.</i>			
9681	Rough, scraggy ginger, rejections from Cochin D,		4.99
9693	Ginger cuttings,		3.19
9727	Exhausted ginger from English ginger ale works,		10.61
9368	Exhausted ginger from extract works,		8.02

GINGER BY-PRODUCTS.

Total.	Ash.		Lime. (CaO.)	ETHER EXTRACT.		Alcohol extract.	Reducing matters by direct inversion calculated as starch.	Starch by diastase method.	Crude fiber.	Nitrogen $\times 6\%$.	Cold water extract.	Total nitrogen.
	Soluble in water.	Insoluble in HCl.		Volatile.	Non-volatile.							
9.35	2.32	0.03	3.53	1.34	2.82	4.04	56.00	53.95	2.37	9.00	15.68	1.44
7.28	2.95	0.02	1.92	1.21	3.43	5.37	58.63	55.61	2.38	9.69	16.10	1.55
8.31	2.63	0.02	2.72	1.27	3.12	4.70	57.31	54.78	2.37	9.34	15.89	1.49
4.72	3.40	0.51	0.28	1.76	3.97	5.23	58.41	56.13	4.28	6.25	14.81	1.00
4.18	2.84	0.11	0.30	1.61	3.82	4.90	56.31	55.05	3.72	9.75	17.55	1.50
3.61	2.64	0.05	0.20	2.01	3.94	5.32	58.05	57.10	3.17	7.56	14.73	1.21
4.17	2.96	0.22	0.26	1.79	3.91	5.15	57.59	56.09	3.72	7.85	15.69	1.24
5.36	2.95	0.08	1.29	1.49	2.95	3.63	62.42	60.31	2.60	7.50	13.22	1.20
3.81	2.42	0.12	0.24	2.47	4.50	6.19	56.65	53.94	4.22	8.00	12.66	1.28
3.66	2.62	0.15	0.25	1.86	3.64	4.89	59.73	58.05	3.68	8.06	12.18	1.29
4.06	2.18	0.06	0.71	2.32	3.75	4.36	58.43	56.62	3.57	8.25	12.66	1.32
3.86	2.40	0.10	0.48	2.09	3.70	4.62	59.08	57.33	3.62	8.15	12.42	1.30
5.48	2.89	0.68	0.56	2.52	5.08	5.98	53.43	49.86	5.10	7.88	12.04	1.26
4.96	2.67	0.23	0.55	3.09	5.15	5.55	53.97	49.05	5.50	7.81	12.41	1.25
5.22	2.78	0.45	0.55	2.80	5.11	5.77	53.70	49.45	5.30	7.84	12.22	1.25
4.34	1.73	0.15	1.07	0.96	3.86	5.18	61.02	58.70	2.62	6.00	12.72	0.96
8.04	1.89	1.28	2.26	0.96	4.02	4.86	60.08	55.40	2.84	4.81	10.92	0.77
6.19	1.81	0.71	1.66	0.96	3.94	5.02	60.55	57.05	2.73	5.40	11.82	0.86
4.14	2.73	0.14	0.26	2.66	5.42	6.30	57.15	53.36	4.31	7.94	13.31	1.27
3.61	2.17	0.08	0.28	2.94	5.28	6.58	57.42	53.08	4.74	7.88	12.38	1.26
4.24	2.65	0.11	0.21	2.60	5.34	6.14	55.65	51.60	4.93	7.94	13.61	1.27
4.00	2.52	0.11	0.25	2.73	5.35	6.34	56.74	52.68	4.66	7.92	13.10	1.27
7.55	4.09	2.29	0.26	1.73	3.37	4.37	55.39	52.48	5.37	7.69	12.51	1.23
6.47	3.60	1.74	0.27	1.84	3.52	4.29	55.62	51.24	5.08	7.25	12.04	1.16
7.01	3.84	2.01	0.26	1.78	3.44	4.33	55.50	51.85	5.22	7.47	12.27	1.19
9.35	4.09	2.29	3.53	3.09	5.42	6.58	62.42	60.31	5.50	9.75	17.55	1.55
3.61	1.73	0.02	0.20	0.96	2.82	3.63	53.43	49.05	2.37	4.81	10.92	0.77
5.27	2.71	0.44	0.80	1.97	4.10	5.18	57.45	54.53	3.91	7.74	13.42	1.23
8.05	4.03	0.89	0.61	6.05	9.55	11.60	31.38	19.35	13.18	7.00	14.65	1.12
9.20	3.90	1.81	1.06	7.06	2.76	9.20	40.23	31.14	8.69	8.69	17.72	1.39
2.12	0.59	0.18	.....	1.61	3.86	4.88	59.86	54.57	5.17	6.94	6.15	1.11
5.05	3.55	1.50	.....	0.13	0.54	1.52	.....	.....	.....	.....	16.42	.....

TABLE XXVII.—CEYLON CINNAMON.

Station No.		Importer.	Molature.
	<i>Ceylon Cinnamon.</i>		
9668	No. 1, extra,	E. R. Durkee & Co., New York,	7.92
9667	No. 1,	" " "	7.90
9666	No. 2,	" " "	7.79
9699	"	Austin, Nichols & Co., New York,	9.34
9640	No. 4,	E. R. Durkee & Co., New York,	8.33
9680	Chips,	Francis H. Leggett & Co., N. York	10.48
	All analyses, { Maximum,		10.48
	{ Minimum,		7.79
	{ Average,		8.63
	<i>Cassia.</i>		
9635	Saigon, thin,	E. R. Durkee & Co., New York,	7.48
9629	"	D. & L. Slade Co., Boston,	6.53
9634	Saigon, medium,	E. R. Durkee & Co., New York,	7.53
9633	Saigon, thick,	" " "	7.06
9628	"	D. & L. Slade Co., Boston,	7.95
9636	Saigon, broken, No. 1,	E. R. Durkee & Co., New York,	7.56
9707	"	Austin, Nichols & Co., New York,	9.12
9698	Saigon, broken, No. 2,	" " "	7.59
	Saigon, average, all analyses,		7.04
9705	Batavia, No. 1,	Austin, Nichols & Co., New York,	8.73
9637	"	E. R. Durkee & Co., New York,	9.53
9627	"	D. & L. Slade Co., Boston,	8.62
9700	Batavia, No. 2,	Austin, Nichols & Co., New York,	9.92
9638	"	E. R. Durkee & Co., New York,	9.01
9686	"	Francis H. Leggett & Co., N. York,	10.16
	Batavia, average, all analyses,		9.33
9704	China or Canton, No. 1, extra,	Austin, Nichols & Co., New York,	11.91
9706	China or Canton, No. 1,	" " "	11.71
9639	" " "	E. R. Durkee & Co., New York,	11.13
9687	" " "	Francis H. Leggett & Co., N. York,	10.95
9630	" " "	D. & L. Slade Co., Boston,	10.87
9708	China or Canton, broken,	Austin, Nichols & Co., New York,	11.08
9737*	" " "		8.90
9631	Coarse, from No. 9737, 47 per cent.,		10.00
9632	Fine, from No. 9737, 53 per cent.,		7.34
	China, average, all analyses, excluding Nos. 9737, 9631, and 9632,		11.27
	All analyses, excluding Nos. { Maximum,		11.51
	{ Minimum,		6.53
	{ Average,		9.24
	<i>Cassia Buds.</i>		
9665	No particulars given,	E. R. Durkee & Co., New York,	7.12
9609	"	D. & L. Slade Co., Boston,	8.74
	Average,		7.93

* Contained large amount of dirt; unfit for consumption until cleaned by sifting.

CASSIA, AND CASSIA BUDS.

Total.	ASH.		ETHER EXTRACT.		Alcohol extract.	Reducing matters by direct inversion calculated as starch.	Crude fiber.	Nitrogen $\times 6\frac{1}{4}\%$.	Total nitrogen.
	Soluble in water.	Insoluble in HCl.	Volatile.	Non-volatile.					
4.16	1.40	0.03	1.46	1.38	12.74	17.55	38.48	4.06	0.65
4.41	2.08	0.05	1.49	1.42	12.70	19.53	38.09	3.69	0.59
4.33	1.61	0.09	1.62	1.46	12.40	22.00	36.40	3.50	0.56
4.41	1.62	0.03	1.49	1.37	11.85	20.12	34.61	3.94	0.63
5.99	2.71	0.02	1.54	1.35	13.60	19.98	35.23	3.25	0.52
5.63	1.79	0.58	0.72	1.68	9.97	16.65	34.38	3.75	0.60
5.99	2.71	0.58	1.62	1.68	13.60	22.00	38.48	4.06	0.65
4.16	1.40	0.02	0.72	1.35	9.97	16.65	34.38	3.25	0.52
4.82	1.87	0.13	1.39	1.44	12.21	19.30	36.20	3.70	0.59
4.78	1.64	0.38	4.88	3.26	5.63	18.36	21.38	5.06	0.81
4.17	2.05	0.17	4.85	3.09	8.70	25.38	17.31	4.63	0.74
4.80	2.02	0.25	5.15	2.34	7.91	25.29	22.65	3.75	0.60
5.99	2.52	0.21	3.94	2.43	5.49	21.37	28.80	3.63	0.58
5.08	2.07	0.08	4.58	2.37	5.14	24.61	25.41	3.75	0.60
6.20	2.28	0.98	3.67	2.55	3.92	20.74	25.09	4.50	0.72
5.08	1.81	0.68	2.43	2.78	6.87	20.57	24.95	4.25	0.68
5.73	2.13	0.21	2.84	4.13	9.16	18.36	25.45	3.87	0.62
5.23	2.06	0.37	4.04	2.87	6.60	21.83	23.88	4.18	0.67
4.75	1.83	0.04	1.59	1.49	16.74	26.95	19.17	4.50	0.72
4.04	1.49	0.06	2.61	1.32	12.39	25.60	17.03	4.88	0.78
4.73	1.85	0.02	2.47	1.45	13.31	20.25	20.31	4.63	0.74
4.46	1.64	0.05	1.23	1.42	13.07	21.15	21.02	5.32	0.85
5.12	1.90	0.05	1.95	1.51	14.50	16.65	22.09	5.19	0.83
4.37	1.63	0.05	2.12	1.39	11.00	18.68	21.51	5.44	0.87
4.58	1.72	0.04	1.99	1.43	13.50	21.55	20.19	4.99	0.80
3.01	1.58	0.10	0.93	1.56	4.57	32.04	23.80	3.31	0.53
3.65	1.06	0.78	1.06	1.87	4.71	27.45	23.66	3.94	0.63
3.47	0.71	1.31	1.44	1.67	7.80	30.28	23.08	3.44	0.55
5.37	0.98	2.42	1.64	1.70	5.21	28.13	23.97	3.94	0.63
4.18	1.28	1.07	1.30	1.75	4.90	24.03	25.70	4.13	0.66
5.58	1.21	2.22	1.48	2.27	4.73	20.57	20.83	4.56	0.73
20.00	1.04	15.47	0.84	1.79	3.76	17.35	24.66	4.18	0.67
4.20	1.30	1.11	1.36	2.27	5.18	22.37	26.51	4.31	0.69
34.02	0.81	28.21	0.37	1.38	2.50	12.91	23.03	4.06	0.65
4.21	1.14	1.32	1.31	1.80	5.32	27.08	24.51	3.89	0.62
6.20	2.52	2.42	5.15	4.13	16.74	32.04	28.80	5.44	0.87
3.01	0.71	0.02	0.93	1.32	4.57	16.65	17.03	3.31	0.53
4.73	1.68	0.56	2.61	2.12	8.29	23.32	22.96	4.34	0.69
4.58	2.88	0.19	4.65	6.27	10.90	10.44	13.89	8.00	1.28
4.70	2.88	0.35	3.11	5.65	10.86	10.98	12.80	7.06	1.13
4.64	2.88	0.27	3.88	5.96	10.88	10.71	13.35	7.53	1.20

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TABLE XXVIII. CLOVES AND

Station No.				Importer.	Weight of 100 cloves in grams.	Moisture.
<i>Cloves.</i>						
9711	Penang,	.	.	Austin, Nichols & Co., New York,	10.04	8.16
9625	"	.	.	D. & L. Slade Co., Boston,	8.51	7.81
	average,	.	.	.....	9.28	7.99
9710	Amboyna,	.	.	Austin, Nichols & Co., New York,	9.26	7.36
9669	"	.	.	Francis H. Leggett & Co., N. York,	10.34	8.06
9622	"	.	.	D. & L. Slade Co., Boston,	9.58	8.25
	average,	.	.	.....	9.73	7.89
9709	Zanzibar,	.	.	Austin, Nichols & Co., New York,	7.64	7.03
9651	"	.	.	E. R. Durkee & Co., New York,	8.22	7.93
9612	"	.	.	D. & L. Slade Co., Boston,	8.15	7.89
	average,	.	.	.....	8.00	7.62
All analyses,				Maximum,	10.34	8.26
				Minimum,	7.64	7.03
				Average,	8.97	7.81
<i>Clove Stems (adulterant).</i>						
9691	Particulars unknown,	.	.	.....		7.95
9652	"	.	.	.....		9.54
	Average,	.	.	.....		8.74

CLOVE STEMS.

ASH.			ETHER EXTRACT.			Reducing mat- ters by direct inversion calcu- lated as starch.	Starch by dias- tase method.	Crude fiber.	Nitrogen $\times 6\%$.	Oxygen ab- sorbed by aque- ous extract.	Quercitannic acid equivalent to O absorbed.	Total nitrogen.
Total.	Soluble in water.	Insoluble in HCl.	Volatile.	Non-vola- tile.	Alcohol extract.							
5.28	3.25	0.05	17.99	6.61	15.58	9.41	2.59	7.94	6.44	2.42	18.90	1.03
5.30	3.48	0.00	20.04	6.25	14.86	8.91	2.70	7.85	7.06	2.36	18.38	1.13
5.29	3.37	0.03	19.02	6.43	15.22	9.16	2.65	7.90	6.75	2.39	18.64	1.08
6.16	3.57	0.02	20.53	6.39	15.20	8.23	3.15	7.97	6.00	2.17	16.90	0.96
6.22	3.72	0.02	20.42	6.63	15.21	8.87	2.59	8.11	5.94	2.08	16.25	0.95
6.17	3.56	0.08	20.45	6.67	15.18	8.19	2.65	7.06	5.94	2.14	16.77	0.95
6.18	3.62	0.04	20.47	6.56	15.20	8.43	2.80	7.71	5.96	2.13	16.64	0.95
5.96	3.61	0.13	17.86	6.24	14.68	9.18	3.15	8.24	6.25	2.63	20.54	1.00
6.22	3.75	0.08	17.82	6.59	13.99	9.50	2.97	9.02	5.88	2.34	18.28	0.94
6.02	3.67	0.10	18.32	6.53	14.25	9.63	2.08	8.60	5.94	2.49	19.50	0.95
6.07	3.68	0.10	18.00	6.45	14.31	9.44	2.73	8.62	6.02	2.49	19.44	0.96
6.22	3.75	0.13	20.53	6.67	15.58	9.63	3.15	9.02	7.06	2.63	20.54	1.13
5.28	3.25	0.00	17.82	6.24	13.99	8.19	2.08	7.06	5.88	2.08	16.25	0.94
5.92	3.58	0.06	19.18	6.49	14.87	8.99	2.74	8.10	6.18	2.33	18.19	0.99
7.68	4.43	0.48	5.13	3.92	7.88	14.53	1.91	18.73	6.00	2.61	20.41	0.96
8.29	4.08	0.71	4.87	3.73	5.70	13.72	2.42	18.69	5.75	2.19	17.16	0.92
7.99	4.26	0.60	5.00	3.83	6.79	14.13	2.17	18.71	5.88	2.40	18.79	0.94

TABLE XXIX.—

Station No.	Importer.	Weight of 100 corns in grams.	Moisture.
9703 Jamaica,	Austin, Nichols & Co., N. Y.,	8.30	9.45
9661 do	E. R. Durkee & Co., N. Y.,	6.61	9.75
9613 do	D. & L. Slade Co, Boston,	5.32	10.14
All analyses,	{ Maximum,	8.30	10.14
	{ Minimum,	5.32	9.45
	{ Average.	6.74	.78

TABLE XXX.—

Station No.	Importer.	Weight of 100 nut- megs in grams.
<i>True Nutmegs, limed.</i>		
9617 Singapore,	D. & L. Slade Co., Boston,	423
9664 Probably Singapore,	E. R. Durkee & Co, N. Y.,	405
9719 " "	Austin, Nichols & Co., N. Y.,	390
Average, Nos. 9617, 9664 & 9719		406
9673 Padang,	Francis H. Leggett & Co., N. Y.,	255
All analyses,	{ Maximum,	423
	{ Minimum,	255
<i>Macassar or Long Nutmegs.</i>		
9674 Limed,		575
<i>Damaged Nutmegs.</i>		
9696 "Grinding Nutmegs," (worm eaten),		104

ALLSPICE OR PIMENTO.

Total.	ASH.		ETHER EXTRACT.		Alcohol extract.	Reducing matters by direct inversion calculated as starch.	Starch by diastase method.	Crude fibre.	Nitrogen $\times 6\%$.	Oxygen absorbed by aqueous extract.	Quercitannic acid equivalent to O ₂ absorbed.	Total Nitrogen.
	Soluble in water.	Insoluble in HCl.	Volatile.	Non-volatile.								
4.15	2.43	0.00	3.57	7.72	14.27	20.65	3.76	20.46	5.19	1.10	8.58	0.83
4.76	2.69	0.03	3.38	5.46	13.71	16.87	1.82	23.98	5.69	1.59	12.48	0.91
4.50	2.29	0.06	5.21	4.35	7.39	16.56	3.54	22.74	6.37	1.03	8.06	1.02
4.76	2.69	0.06	5.21	7.72	14.27	20.65	3.76	23.98	6.37	1.59	12.48	1.02
4.15	2.29	0.00	3.38	4.35	7.39	16.56	1.82	20.46	5.19	1.03	8.06	0.83
4.47	2.47	0.03	4.05	5.84	11.79	18.03	3.04	22.39	5.75	1.24	9.71	0.92

NUTMEGS.

Moisture.	ASH.		ETHER EXTRACT.		Alcohol extract.	Reducing matters by direct inversion calculated as starch.	Starch by diastase method.	Crude fibre.	Nitrogen $\times 6\%$.	Total Nitrogen.
	Total.	Soluble in water.	Insoluble in HCl.	Volatile.	Non-volatile.					
5.79	2.23	0.84	0.00	3.40	36.87	10.80	25.60	23.34	2.49	1.12
8.98	2.13	0.82	0.01	2.56	36.29	10.42	25.56	23.62	2.38	1.05
8.12	2.48	0.93	0.00	3.10	36.94	11.09	25.51	24.20	2.65	1.06
3.63	2.28	0.86	0.00	3.02	36.70	10.77	25.56	23.72	2.51	1.08
10.83	3.26	1.46	0.00	6.94	28.73	17.38	17.19	14.62	3.72	1.08
10.83	3.26	1.46	0.01	6.94	36.94	17.38	25.60	24.20	3.72	1.12
5.79	2.13	0.82	0.00	2.56	28.73	10.42	17.19	14.62	2.38	1.05
5.24	3.32	1.25	0.00	4.70	32.88	16.79	29.97	29.25	2.07	1.11
17.23	6.37	4.33	0.12	9.76	11.32	14.71	5.71	1.63	7.95	1.49

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TABLE XXXI. — ANALYSES OF

Station No.		Importer.
	<i>True Mace:</i>	
9619	Banda,	D. & L. Slade Co., Boston.
9662	Penang,	E. R. Durkee & Co., New York,
9717	"	Austin, Nichols & Co., New York,
9677	" No. 2,	Francis H. Leggett & Co., New York,
9694	"Grinding Mace" (damaged),	
	All analyses, exclud- ing No. 9694, {	Maximum,
		Minimum,
		Average,
	<i>Other Varieties of Mace</i>	
9675	Macassar,	
9676	Bombay (adulterant),	

TABLE XXXII. — MISCELLANEOUS

Station No.		ASH.			
		Moisture.	Total.	Soluble in water.	Insoluble in HCl.
9718	English-walnut shells,	7.69	1.40	0.77	0.00
9728	Brazil-nut shells,	9.08	1.59	1.06	0.17
9730	Almond shells,	7.80	2.86	2.39	0.05
9735	Cocoanut shells,	7.36	0.54	0.50	0.00
9729	Date stones,	8.24	1.24	0.76	0.04
9733	Spruce sawdust,	8.77	0.23	0.16	0.00
9734	Oak sawdust,	5.73	1.22	0.32	0.02
9731	Linseed meal,	8.71	5.72	1.74	0.55
7830	Cocoa shells,	10.44	8.40	4.66	0.83
9736	Red sandalwood,	4.42	0.70	0.28	0.07

MACE.

Moisture.	ASH.			ETHER EXTRACT.		Alcohol extract.	Reducing matters by direct inversion calculated as starch.	Starch by diastase method.	Crude fiber.	Nitrogen $\times 6\%$.	Total Nitrogen.
	Total.	Soluble in water.	Insoluble in HCl.	Volatile.	Non-volatile.						
10.75	1.81	1.09	0.00	8.65	22.00	23.05	32.35	27.90	3.04	6.25	1.00
12.04	1.85	1.06	0.06	6.27	22.56	22.07	34.42	30.43	2.99	6.37	1.02
9.78	1.85	1.06	0.03	6.97	21.63	22.58	33.39	30.04	2.94	6.25	1.00
11.62	2.54	1.33	0.21	8.45	23.72	24.76	26.77	23.12	3.85	7.00	1.12
12.51	5.74	2.37	1.13	14.97	20.96	22.27	8.32	4.73	7.64	10.94	1.75
12.04	2.54	1.33	0.21	8.65	23.72	24.76	34.42	30.43	3.85	7.00	1.12
9.78	1.81	1.06	0.00	6.27	21.63	22.07	26.77	23.12	2.94	6.25	1.00
11.05	2.01	1.13	0.07	7.58	22.48	23.11	31.73	27.87	3.20	6.47	1.03
4.18	2.01	1.11	0.03	5.89	53.54	32.89	10.39	8.78	4.57	7.00	1.12
0.32	1.98	1.37	0.07	4.65	59.81	44.27	16.20	14.51	3.21	5.06	0.81

SPICE ADULTERANTS.

Volatile.	ETHER EXTRACT.		Reducing matters by direct inversion calculated as starch.	Starch by diastase method.	Crude fiber.	Nitrogen $\times 6\%$.	Oxygen absorbed by aqueous extract.	Quercitannic acid equivalent to O ₂ absorbed.	Total Nitrogen.
	Non-volatile.	Alcohol extract.							
0.12	0.55	1.84	19.30	1.01	56.58	1.69	0.53	2.08	0.27
0.07	0.57	1.01	12.96	0.73	50.98	4.19	0.33	1.30	0.67
0.16	0.64	5.16	22.72	0.84	49.89	1.75	0.40	1.56	0.28
0.00	0.25	1.12	20.88	0.73	56.19	1.13	0.47	1.82	0.18
0.36	8.38	16.72	20.88	2.19	5.72	5.31	0.61	2.34	0.85
0.07	0.77	1.50	15.48	1.13	64.03	0.56	0.30	1.17	0.09
0.07	0.84	6.25	17.10	1.68	47.79	1.63	3.13	12.22	0.26
0.04	6.58	9.46	21.15	14.06	8.30	31.81	1.00	3.90	5.09
1.00	2.99	4.77	8.68	3.15	14.12	16.19	1.26	4.94	2.59
1.21	11.47	19.37	6.79	1.12	52.30	3.06	0.59	2.29	0.49

DISCUSSION OF ANALYSES.

The analyses reported herewith, in the tables on pages 198 to 211, together with those made at the Department of Agriculture, should serve as sufficient data for fixing standards of purity for these spices; but it is not the purpose of this article to formulate a set of standards, as that work has already been undertaken by the Association of Official Agricultural Chemists.

A discussion of the analyses of each spice follows:

Black Pepper.

Of the methods employed in our work the determinations of the non-volatile ether extract and of the nitrogen in this extract furnish the most valuable means of detecting adulterants of vegetable origin in both black and white pepper.

When a sample of black pepper is adulterated with buckwheat hulls, cocoanut shells, or some other material deficient in ether extract, the percentage of non-volatile extract will be diminished, without changing perceptibly the parts of nitrogen in 100 parts of the extract; but when the sample is mixed with linseed meal or some other oily material, the percentage of non-volatile ether extract may remain about the same as in the original pepper, but the parts of nitrogen in 100 of the extract will be reduced.

The nitrogen content of the extract of the samples analyzed is quite constant, varying only from 3.82 to 4.06 parts in 100 of the extract.

Both the alcohol and ether extracts are highest in Acheen black pepper, the cheapest grade on the market, and for this reason a considerable amount of adulterant in Acheen pepper might not be disclosed by a determination of either of these extracts.

The starch and reducing matters, by direct inversion, are highest in the best grades of black pepper, and lowest in the cheapest grades, while the reverse is true of fibre, total ash,

and ash soluble in water, and ash insoluble in HCl. Determination of these six ingredients may be useful to some extent in ascertaining the quality of a sample, if not its purity.

From our analyses, it appears that genuine black pepper of low grade may contain more than 5 per cent. of ash and 14 of fiber, which are given in the Austrian codex as the maxima; although 2 per cent. of sand, the maximum of the codex, has not been exceeded in any of our analyses. The per cent. of nitrogen and of albuminoids in adulterated pepper may be either greater, less, or the same as in the genuine pepper, depending on the nature of the adulterant used.

White Pepper.

Determinations of the ether and alcohol extracts and of nitrogen in the ether extract are the best means of detecting starchy adulterants. The parts of nitrogen in 100 of ether extract range from 4.05 to 4.45.

If olive stones, nut shells, sawdust, or similar materials are used as adulterants, determinations of starch (best by the diastase method) and of fiber will be valuable for their detection.

In all cases the percentages of total ash in pure white pepper are below 3 per cent., the maximum of the Austrian codex. The percentage of nitrogen and albuminoids will not usually furnish evidence of adulteration.

Cayenne Pepper.

The percentages of non-volatile ether extract range from 17.17 to 21.81, and of alcohol extract, from 21.52 to 27.61. These figures are much higher than in farinaceous materials, fruit stones, nut shells, and most of the other cayenne adulterants. Determination of starch by the diastase method is of great value when farinaceous matter is present. Red sandal wood is not readily detected by any of the methods just mentioned, but, if present in considerable amount, a determination of fiber should furnish valuable evidence. Other woods, nut shells, fruit stones, also increase the per cent. of fiber.

All of the samples contain less than 6 per cent. of ash, the limit of the Austrian codex.

Ginger.

The composition of the cereal products which are usually employed as ginger adulterants is not very different from that of pure ginger, and the microscope must usually be depended on to detect such materials.

Adulterated ginger may show a deficiency of volatile ether extract, but, as genuine ginger sometimes contains less than 1 per cent., a low percentage of volatile ether extract alone is not sufficient evidence of adulteration.

The highest per cent. of calcium oxide in any of the samples not evidently limed is 0.71, but in the limed samples the percentages range from 1.07 to 3.53. As carbonate and sulphate of lime are used to adulterate ground ginger, it should be determined whether the grinding of limed ginger is legitimate, and, if so, what maximum of lime should be allowed in ground ginger.

The two samples of exhausted ginger examined differ widely from each other in composition. No. 9727, the sample from the ginger-ale works, having been treated with water, is deficient in cold-water extract, water-soluble ash, and alcohol extract, but not in ether extract. The other sample, No. 9368, which was obtained from the extract factory, contains the full amount of cold-water extract and water-soluble ash, but is strikingly deficient in alcohol extract and ether extract, both volatile and non-volatile, and must have been extracted with some solvent other than water—probably strong alcohol.

Acetic acid is used in this country by some of the extract manufacturers, but we have no figures which show the composition of ginger after extraction by this solvent.

Cinnamon, Cassia, and Cassia Buds.

The only marked difference between Ceylon cinnamon and cassia, brought out by the analyses, is in the fiber, the former containing an average of 36.20, the latter of 22.96 per cent.

Cassia buds have a higher percentage of non-volatile ether extract and nitrogen, and a lower percentage of fiber, than the bark, but are otherwise similar in composition.

Saigon cassia contains more volatile oil than the Batavia and China varieties, and Ceylon cinnamon. Batavia cassia and

Ceylon cinnamon have about twice as much alcohol extract as Saigon or China cassia.

We have also found that Batavia cassia differs from the other varieties, in that it contains a gum which, on treatment with water or weak alcohol, forms a glutinous paste. (See foot note, p. 187).

The analyses of the sample of broken China cassia, No. 9737, and of the coarse and fine materials obtained from this sample by sifting, show to what extent cassias may be mixed with dirt in China.

Ground cassia should not contain more than 7 per cent. of ash and little, if any, more than 2 per cent. of sand.

Aside from determination of ash, it is doubtful if chemical analysis of cassia will be of use in detecting adulteration.

Cloves.

This spice is rich in volatile ether extract, alcohol extract, and tannin, and determination of these constituents will usually be sufficient when only non-starchy adulterants have been detected by the microscope.

As cloves contain no starch, a test with iodine solution will disclose farinaceous matter, or any other foreign material containing starch.

By the diastase method a small amount of reducing matter is obtained (1.91 to 2.42 per cent. calculated as starch), but the amount is too small to impair the usefulness of this method as a means of disclosing starchy adulterants. The samples of cloves examined contain less than 10 per cent. of fiber and between 0.94 and 1.13 per cent. of nitrogen.

There is no common adulterant which does not differ radically in composition from cloves, in respect to several ingredients.

Red sandal wood cannot be readily detected by the determination of starch or alcohol extract, but it contains almost no volatile ether extract and has six times as much fiber as cloves.

The Austrian codex states that pure cloves will not contain more than 8 per cent. of ash. Our figures are well within this limit.

Clove stems have about one-quarter as much volatile oil, half as much fixed oil and alcohol extract, and over twice as much fiber as cloves.

Allspice.

The samples analyzed differ materially in composition. Clove stems, a common adulterant, cannot probably be distinguished from allspice by chemical analysis.

On comparing the analyses of allspice with the analysis of cocoanut shells in Table XXXII, p. 210, it will be seen that the two materials are radically different in composition, and that this adulterant, when present in considerable amount, can be detected by analysis.

Nutmeg.

True and long nutmegs have about the same chemical composition. The addition of almost any available adulterant, excepting oil seeds or oil cake, will tend to lower the percentage of volatile and non-volatile ether extract. When shells or sawdust are present, fiber determinations should be made.

As the starchy matter of the sample of grinding nutmegs had been eaten out by insects (see description of sample), only 1.63 per cent. of starch was found by the diastase method. The percentage of fixed oil is also much lower than in sound nutmegs, but that of volatile oil is abnormally high, due, probably, to the removal of other matters.

Mace.

True mace is readily distinguished from Macassar or Bombay mace by the percentage of fixed oil and starch, as shown in the following statement:

	Non-volatile ether extract.	"Starch" by diastase method.
True mace (Aver., Nos. 9619, 9662, 9717),	22.48	27.87
Macassar mace,	55.54	8.78
Bombay mace,	59.81	14.51

None of the varieties contains starch, in the ordinary acceptance of the term, as iodine produces a red and not a blue coloration. Tschirch* has shown, however, that the irregular

* Ber. d. Deutsch. bot. Ges., 6, 1888, 138. See also Tschirch, *Angewandte Pflanzen-anatomie*, 1888, pp. 99 and 100, and same author, *Anatomischer Atlas*, 1887, pp. 252 and 253.

shaped granules which are evident under the microscope consist of starch granules impregnated with amyloextrin, to which granules he has given the name, "amyloextrin-starch."

Our experiments show that this carbohydrate is readily soluble in diastase, and may be determined by the diastase method.

The results thus obtained are valuable as a means of detecting adulteration, and of distinguishing true from Macassar and Bombay mace.

NOTE ON THE CHEMICAL COMPOSITION OF MUSTARD FLOUR.

Pure mustard flour is prepared from one variety of mustard seed, or from a mixture of different varieties, with the removal of the hulls and usually of a portion of the fatty oil. As the product contains only a portion of the seed, standards of purity cannot be based on analyses of the whole seed from which it is prepared.

No analyses of mustard seed or of authenticated samples of mustard flour have been made at this Station, but on page 168 are given analyses of 26 brands of mustard flour sold in sealed packages bearing the names of the manufacturers.

The maxima, minima, and average results of the analyses of 18 samples which were not found adulterated or artificially colored, either by chemical or microscopical examination, are as follows :

	Total ash.	ETHER EXTRACT.		Reducing matters by direct inversion calculated as starch.	Starch by diastase method.	Crude fiber.	Nitrogen, $\times 6\frac{1}{4}$.
		Volatile.	Non-volatile.				
Maximum,	7.35	1.90	28.10	6.12	2.08	4.87	43.56
Minimum,	4.81	0.00	17.14	1.85	0.28	1.58	35.63
Average,	5.99	0.56	20.61	4.33	1.07	2.58	39.57

WHEAT FLOUR.

By A. L. WINTON.

A sample of flour bought in another State and referred to this station for examination was found to contain a considerable quantity of maize starch.

To discover whether the flour sold in Connecticut markets is adulterated in this way, twenty-five different brands of flour were bought and carefully examined microscopically. No evidence of any form of adulteration was found.

The names of the brands examined, and of the dealers from whom they were bought are given in Table XXXIII.

TABLE XXXIII. — WHEAT FLOUR NOT FOUND ADULTERATED.

Station No.	Brand.	Dealer.
9602	The King's Best, H. H. King & Co., Minneapolis,	<i>Hartford.</i> K. Goldberg, 66 Talcott St.
9603	Townshend's Butterfly, Stillwater, Minn.,	T. A. Shaw, 535 Main St.
9604	Crocker's Best XXXX, Minneapolis,	T. A. Shaw, 535 Main St.
9601	Shumacher's White Cloud, Akron, O.,	E. P. Yates & Co., 711 Main St.
9436	White Seal Fancy Patent, Norton & Co., Chicago,	<i>New Haven.</i> Edward Boyhan, 554 Grand Ave.
9443	The Hoosier Hulled Whole Wheat Flour, Seymour, Ind.,	I. B. Chandler, 101 Dixwell Ave.
7806	Fancy Roller Process Hungarian Patent, Pt. Jefferson Milling Co., L. I.,	Geo. W. Clark, 987 State St.
9437	Roller Process Princess, Fancy Family, St. Louis,	G. W. Cooper, Grand Ave. & Artizan St.
9442	Jones Hungarian Superlative, Hecker, Jones, Jewell Milling Co.,	A. F. Copeland, 1206 State St.
9444	Staten Island Milling Co.'s Fancy Patent, Minnesota,	J. L. Folley, Grand Ave. & Bradley St.
9440	Pillsbury's Best XXXX, Pillsbury Washburn Flour Mills, M'apolis,	Philip Hugo, Edward & Nash Sts.
9438	Prima Donna, Anchor Mill Co., Superior,	F. A. Hull, 399 Grand Ave.
9439	White Loaf, Bryan, Miner & Read, New Haven,	Conrad Rausch, Foster & Avon Sts.
9441	Gold Medal, Washburn Crosby Co., Minneapolis,	J. J. Sullivan, Nash & Eagle Sts.
9445	Daily Bread, Liberty Mills,	389 Grand Ave.
9701	Wilson's Choice White Rose Pastry Flour,	<i>New London.</i> M. Wilson Dart, Howard & Bank Sts.
9702	Bridal Veil, Central Milling Co., Buffalo,	Edward Keefe, 495 Bank St.
9487	Schumacher's Patent, Akron, Ohio,	<i>Waterbury.</i> D. L. Dickenson, 431 W. Main St.
9485	Christian's Superlative, Pettit Mills, Minneapolis,	Dillon's Cash Store, 43 E. Main St.
9486	Gold Seal Fancy Patent, The F. C. Bushnell Co., New Haven,	N. W. Heater, 157 E. Main St.
9488	The Angelus, Thompson Milling Co., Lockport, N. Y.,	798 Bank St.
9523	Fancy Patent Superlative, E. G. W. & Co., Minneapolis,	<i>W. Winsted.</i> Chas. Smith, Main St.
7970	Schumacher's XXX Graham, Akron, Ohio,	<i>Willimantic.</i> H. Levin, 493 Main St.
9521	Ceresota, Western Consolidated Milling Co., Minneapolis,	<i>Winsted.</i> I. K. Camp, Main St.
9522	Peerless XXXX, E. G. W. & Co., St Louis,	Larkin & Sparks, Main St.

FOOD PRODUCTS EXAMINED FOR THE DAIRY COM-
MISSIONER IN THE YEAR ENDING JULY 31, 1897.

BY E. H. JENKINS.

A considerable part of the chemical and polariscopic work here described was done by Messrs. Winton, Ogden & Mitchell.

All adulterated samples were also examined by Mr. Jenkins, who was summoned to attend court cases of prosecution for violation of the law.

VINEGAR.

Thirty-two samples sent by the Dairy Commissioner were examined during the twelvemonth ending July 31, 1897.

Solids. Of the samples marked "cider vinegar",
3 had between 1.0 and 1.5 per cent. of solids.
9 " " 1.5 " 2.0 " " "
16 " over 2.00 per cent. of solids.

The highest percentage found was 3.57.

Acidity. Of the samples marked "cider vinegar",
2 had between 2.5 and 3.0 per cent. of acidity.
1 " " 3.0 and 3.5 " " "
5 " " 3.5 " 4.0 " " "
20 " over 4.0 per cent. of acidity.

The highest percentage found was 6.41.

Three samples marked "White Wine Vinegar" contained from 0.15 to 0.25 per cent. of solids, and from 4.53 to 4.60 per cent. of acidity.

MOLASSES.

Two hundred and three samples of molasses and syrups have been examined in the year ending July 31, 1897.

Method of Examination. — 13.024 grains (one-half the normal weight) of molasses were dissolved in about 80 cc. of water, 3 cc. of basic lead acetate were added, the volume was made up to 100 cc. and the whole was thoroughly mixed

and passed through a dry filter. The rotation of the clear and nearly colorless filtrate was determined, in a 200 mm. tube, with a Schmidt and Haensch half shade double compensation polariscope. The reading, doubled, gave the sugar degrees or per cent. No correction was attempted for the volume of the lead precipitate.

To 50 cc. of the filtrate referred to above, were added 5 cc. conc. C. P. hydrochloric acid, and, after thorough mixing, the flask containing the solution was placed in a cold water bath, which was then quickly heated to 68° C. After standing at that temperature for 10 minutes, the contents of the flask were quickly cooled and the solution, filtered from lead chloride when necessary, was examined in a 220 mm. tube, provided with a water jacket. The temperature was noted with the reading. This reading, doubled, gave the sugar degrees after inversion.

Water, heated to 86° C., was then passed through the jacket and a third reading made at that temperature.

The rotatory power of dextrose is not greatly affected by the temperature, but that of levulose diminishes as the temperature rises, so that invert sugar becomes practically inactive at about 86°.

Results of Examination.—Of the 203 samples of molasses and syrups examined for the Dairy Commissioner, 34 were adulterated with glucose syrup and 169 were free from this adulterant. The percentage of adulterated samples was 20.1. In the previous year it was 32.8. The numerous prosecutions brought by the Commissioner have probably lessened the introduction and sale of adulterated molasses in this State.

It is also noticeable that the proportion of glucose added in the adulterated samples is less than in the previous year. There are a considerable number of samples which, by direct polarization, show no higher polarization sugar than is found in some genuine molasses (50 to 60 per cent.). But polarization after inversion at room temperature and at 86° C. demonstrates the presence of an adulterant.

MAPLE SYRUPS.

Two samples, labeled "Maple Syrup," were examined for the Commissioner, and were found to contain no glucose.

SYRUPS.

Four samples, labeled "Syrup," "Crystal Syrup," or "Vanilla Drips," tested for the Commissioner, were found to consist largely of glucose syrup.

CREAM.

A sample marked "Bryant's Pasteurized Cream," contained 47.25 per cent. of butter fat. A sample marked "Pure Cream, the Mount Philip Farm, Weatogue," contained 47.0 per cent. of butter fat. In neither sample was there found either borax or formaldehyde.

BUTTER AND OLEOMARGARINE.

Seventeen samples have been examined for the Dairy Commissioner during the year ending July 31, 1897.

Methods of Examination.

Specific Gravity. — This is determined at the temperature of boiling water by means of Westphal's balance, as first described by Estcourt and by J. Bell, Chem. News, Vols. xxxiv, 254, and xxxviii, 267.

The balance is so adjusted that water at 15.5° C. shall represent unity.

With distilled water, at the temperature of boiling, the instrument indicates a specific gravity of .9625. If the specific gravity of fat at the temperature of boiling water is desired, using the weight of an equal volume of distilled water, at that temperature as a standard, the reading of the instrument must be multiplied by 1.039.

We have also used for this determination a specific gravity spindle made by Greiner of New York City, 6½ inches long, reading from .8550-.8700, and graduated to show differences of .0005 in sp. gr.

Volatile Fatty Acids. — These were determined by the Reichert method, the saponification being effected by the method of Leffmann and Beam, as described in the Analyst, xvi, 1891, p. 153. The result of the determination is expressed by the number of cubic centimeters of $\frac{1}{10}$ normal sodium hydroxide solution necessary to neutralize the acid distilled from 2.5 grams of the fat.

Results of Examination.

Of the samples examined, 10 were butter and 7 were imitation butter, or oleomargarine.

The specific gravity of the melted fat, determined by the method above named, in a single sample of pure butter, was 0.8649; in the samples of imitation butter, or oleomargarine, it ranged from .08596 to 0.8062.

The volatile fatty acids determined as above described, in 2.5 grams of butter-fat, ranged from 13.50 cc. to 16.50 cc. In the like quantity of imitation butter they ranged from 0.13 to 0.70.

SUMMARY.

The following table contains a summary of the results of the work done during the past year in the examination of food products :

	No. of samples not found to be adulterated.	No. of samples found to be adulterated.	No. of samples containing borax or salicylic acid, not otherwise adulterated.	Total.
Collected by the Station —				
Purchased in Connecticut Market :				
Jellies,	27	43	..	70
Preserves, Jams, Marmalades, etc.,	6	45	..	51
Teas,	89	..	..	89
Coffee,	34	11	..	45
Coffee Compounds,	22	..	..	22
Coffee Substitutes,	6	..	..	6
Flour,	25	..	..	25
Ginger,	67	24	..	91
Malt Liquors,	35	..	12	47
Sausage,	5	..	14	19
Honey,	27	10	..	37
Maple Syrup,	3	..	..	3
Milk,	13	..	..	13
Cream,	19	..	4	23
Canned Soups,	32	..	..	32
Canned Vegetables,	65	..	..	65
Chili Sauce, . . . . .	..	1	..	1
Mince Meat,	9	..	..	9
Ground Spices in labeled packages,	142	28	..	170
	626	162	30	818
Purchased from Importers :				
Pure Spices, Spice By-products, etc.,	125	..	..	125
Total collected by the Station,	751	162	30	943
Collected by the Dairy Commissioner :				
Vinegar,	20	12	..	32
Molasses,	169	34	..	203
Syrups,	4	..	..	4
Cream,	2	..	..	2
Butter,	10	7	..	17
Total collected by Dairy Commis'r,	205	53	0	258
Sent by Individuals :				
Milk,	96	..	..	96
Cream,	9	..	..	9
Total from all sources,	1,061	215	30	1,306

SOME COMMON DISEASES OF MELONS.

BY WM. C. STURGIS.

For several years the growing of melons in southern Connecticut has been attended with discouraging results, sometimes amounting to complete failure. Before striking off melons from the list of plants which can be grown with profit, it is well to consider the causes which have led to failure, and to attempt the application of remedial measures.

In common with most members of its family, the melon is a plant of rank growth and succulent, delicate tissues. The fruit contains about eighty-four per cent. of water, and the leaves and stems when dried under pressure show, by their extreme thinness, that they also contain a very high percentage of water when fresh. For its full development, the plant requires a light, warm soil, and it thrives best under conditions of high temperature, dry air, and continuous sunshine. The melon plant is as delicate in constitution as in texture. It does not adapt itself readily to varying conditions or sudden climatic changes, its physiological balance is easily upset, while its tissues offer little resistance to the attacks of insects, fungi, and bacteria.

I

At least three different causes are accountable for the recent failures of the melon crop. The first and most important is unquestionably a bacterial disease which has been very accurately studied and described by Dr. E. F. Smith of the United States Department of Agriculture. Unfortunately, we have as yet no extended account, in English, of Dr. Smith's investigations, but the disease itself is doubtless familiar to all melon-growers. It is characterized by a sudden wilting of the leaves, which is quite independent of atmospheric conditions, being as liable to occur in cloudy as in clear weather. As far as my experience goes, a plant thus wilted never recovers as do plants which droop from the effects of sudden sunshine after cloudy weather. Usually only a single plant

in a hill shows the disease; occasionally all the plants in a hill will be smitten at once; but, in any case, a plant once attacked is doomed; the leaves wilt down and wither completely, while the stem either dries or becomes food for eel-worms, putrefactive bacteria and other agents of decay. It sometimes happens that where a vine branches near the ground, one branch may be attacked and the rest of the vine remain healthy; if, in such a case, the diseased branch is cut off at its junction with the main stem, the rest of the vine may escape infection. I have noted several cases during the past summer in which a vine was saved by the removal of a diseased branch before the infection had reached the main stem.

The specific cause of this disease, Dr. Smith describes as a rod-shaped, ciliated, motile bacillus (a name applied to a certain genus of bacteria), isolated or united in pairs and occurring in the vessels of the leaf-ribs and stem, from the cut ends of which it oozes in slimy, milk-white drops. It grows readily in pure cultures on a number of the usual culture media, such as beef-broth, potato decoction, boiled potato, etc. It requires the presence of free oxygen and an alkaline medium for its best development; it is extremely sensitive to heat, a temperature of 43° C. (108° F.), maintained for ten minutes, being sufficient to destroy it, and, while very sensitive to desiccation, it may live for months if kept moist.

By isolating this bacillus in pure cultures and inoculating melons and cucumbers with it, as well as by transferring it directly from diseased to healthy plants, Dr. Smith proved conclusively that the organism in question is the specific cause of the disease, and that it is probably identical with a similar organism attacking squashes. According to Dr. Smith's published researches, the immediate cause of the death of melon plants invaded by this bacillus is not the destruction of tissues, but the choking of the vessels by its accumulation within them and the consequent arrest of water-supply to the leaves. The plants become infected through the leaves, probably by the agency of insects such as the striped cucumber-beetle (*Diabrotica vittata*) and the squash-bug (*Coreus tristis*).

When the infected leaf wilts, the bacillus has already traversed its vessels and reached the stalk; here it multiplies, at first in the spiral vessels only, but later in the large dotted ducts, choking them up more or less. At first there is no destruction of the tissues, the diseased stem appearing quite nor-

mal, but later the walls of the vessels are destroyed and large cavities are formed, filled with the bacillus. Owing to the predilection shown by this organism for the *tracheae* or vessels of the stem, it has been named by Dr. Smith *Bacillus trachicophilus*.

That this is actually the disease which, for the past five years at least, has destroyed a large percentage of the melon vines in Southern Connecticut there can be no doubt. Continuous observation in the field, in three separate localities, during the past season, convinced me that the chief source of trouble was the bacterial organism above mentioned. A plant wilts suddenly, without apparent cause; from cut stems of wilted plants kept under a bell-jar in the laboratory, viscid, milky drops ooze out, swarming with motile bacilli, apparently identical with those described by Dr. Smith; microscopic examination of diseased stems shows that the large vessels (water-channels) of the wooden portion are almost filled with yellowish masses of the same organism, while the petioles of squash leaves inoculated with a small portion of one of the viscid drops from a diseased melon stem show the characteristic symptoms of the disease in the course of five days.

One other point, however, is worthy of mention. In examining a vine from which a wilted branch had been removed a few days previously, it was seen that the main stalk at the cut was covered with a dense whitish mold, and that the whole plant had begun to droop. It was thereupon pulled up and further search brought to light another wilted plant, the base of which was likewise covered with white mold. This plant was also removed and both were microscopically examined the following day. The mold proved to be a species of *Fusarium*, the vegetative portion of which had permeated the stalk; where the latter was broken and the tissues were exposed, the fungus had fruited, producing vast numbers of pointed, cylindrical, slightly curved, 3-5-septate spores, measuring $30-54 \times 4.5-5.7 \mu$. The two stalks were divided longitudinally and placed in a moist atmosphere under a bell-jar. In twenty-four hours they were examined again and the mycelium of the *Fusarium* was found to have given rise to masses of minute elliptical bodies, non-septate, and measuring $8.5 \times 3.8 \mu$. The genus *Fusarium* includes a number of so-called species, most of which occur on dead vegetable matter, though a few are

known to infest living plants. The mere fact that a member of the genus occurs in the tissues of the crown of melon plants would not be worth mentioning were it not that more than one disease of plants, characterized at first by wilting, has been traced directly to the accumulation in the water-passages at the crown, of the mycelium and spores of a *Fusarium*. Such a disease in cotton has been described by Atkinson, and in tomatoes by Massee. In the Twenty-first Annual Report of this Station (1897), I described a disease of carnations apparently due to the same cause. Furthermore, Smith describes* a disease of watermelons in the South as caused by a fungus which gains access to the plant through the roots, appears abundantly at the crown, produces on the surface of the stem "large lunulate, 3-5-septate conidia ($50\ \mu$ long)," and, in the internal tissues of the stem, produces "minute, elliptical, colorless conidia ($10\ \mu$ long) . . . on white mycelium which plugs the water ducts," and thus causes the plants to wilt and finally die. The resemblance between this fungus, which Dr. Smith has named provisionally *Fusarium niveum*, and the one found by me in wilted muskmelon plants, as well as the similarity, in appearance, of plants infested by them, warrants the suspicion that the wilt-disease which has been so prevalent lately in our muskmelon fields may be due in part to the attacks of a species of *Fusarium*, possibly the same as that associated with the wilt of watermelons.

II

The second disease which, in former years, has caused serious injury to muskmelons, is a black mold occurring in circular patches upon the leaves, and known as *Alternaria Brassicae*, var. *nigrescens*. This fungus was noted and its effects described in our Nineteenth Annual Report (1895.)

III

The third trouble is entirely different from either of those described above. When cool, cloudy weather alternates with hot sunshine it is frequently noticed that the large leaves near the center of the hills turn yellow at their margins. Later, these yellowed margins become brown and dry, and finally the whole leaf is diseased. As the leaves die down they begin to

* Proc. Am. Asso. Adv. Sc., XLIII, p. 289; and XLIV, p. 190.

decay, the tissues become infested with eel-worms, putrefactive bacteria and molds of various kinds, and sometimes the whole plant is ruined. In this case the initial injury is due to a derangement of the proper activities of the plant. I have frequently had occasion to mention the dangers to plant-life of sudden atmospheric changes, especially from damp, cloudy weather and low temperature, to a dry, hot air. When both the soil and the atmosphere are surcharged with moisture, evaporation takes place very slowly from the leaves, and is abundantly compensated for even by the lessened absorptive activity of the roots due to the low temperature of the soil. If now the plants are suddenly exposed to a hot sun, evaporation from the leaves becomes very active, while the roots are unable to respond to the sudden demand made upon them, since the soil temperature changes but slowly. Consequently the leaves give off water more rapidly than they receive it, the cells tend to collapse and, if the equilibrium is not speedily restored either by increasing the absorptive activity of the roots through warming the soil, or by decreasing the evaporative activity of the leaves through shading or sprinkling, the leaf tissues will die. Such a condition is, of course, much more liable to occur in the case of plants, like the melon, which absorb water with avidity and retain a very large quantity of it in their delicate tissues, than in plants with denser tissues requiring and retaining less water.

There are, then, three distinct troubles to which are to be ascribed the recent losses in our melon-fields:— First, a Wilt caused by the bacterial organism *Bacillus tracheiphilus*, and possibly also by a fungus of the genus *Fusarium*; secondly, a blight of the leaves occasioned by a variety of the fungus *Alternaria Brassicae*; and thirdly, Leaf-Burn, a physiological trouble that follows sudden disturbance of equilibrium between water-absorption and evaporation.

With the view of obtaining further information regarding the possible control of these troubles, three experiments were conducted during the past summer in different localities and on different soils, viz. at Saugatuck, in Fairfield county, and at New Haven and North Haven, in New Haven county. At Saugatuck the melons occupied a rather low piece of ground and a fine, dark, loamy soil, not particularly favorable for melons except in a very dry season. Ten rows were selected, each containing sixteen hills. Ten hills in each row

were treated with fungicides, the remaining six serving as checks. Three rows received Bordeaux mixture, three potassium sulphide, one sulphur, and three "Laurel Green," a "combined fungicide and insecticide" prepared by the Nichols Chemical Company, Syracuse, N. Y., and containing ten per cent. of copper and seven and three-quarters per cent. of arsenic.* The melons at North Haven occupied an ideal soil for melons, warm, sandy, and deep. A plot was selected comprising twelve rows, with twelve hills in each row. Six hills in each row received fungicidal treatment, the remainder served as checks. Besides this treatment, one-half of the hills in each plot were mulched heavily with tobacco stems in order, if possible, to prevent the inroads of melon-lice, and to guard the roots from sudden changes of temperature. The fungicides applied to these plots were the same as those used at Saugatuck. The melons at New Haven were on a dry, rather gravelly soil, and served only to test the effects of a heavy mulch of marsh hay, about two-thirds of the field being mulched in this manner.

From these three experiments it was thought probable that there would be obtained some definite information as to the efficacy of root protection and the application of fungicides in preventing disease. In case the treated and untreated plants alike should show no sign of disease, the experiments would still serve to show the effect of fungicides on the delicate foliage of the vines.

The effect of mulching, as seen in the field of Mr. A. N. Farnham of New Haven, where marsh hay was used, and at Mr. H. P. Smith's of North Haven, where tobacco stems served a like purpose, was not particularly striking. At Mr. Farnham's the mulch checked the growth of weeds and protected the melons from the dirt, but all of the vines, whether mulched or not, showed extraordinary vigor, and it is very doubtful whether mulching with hay will, in ordinary seasons, prove remunerative. In periods of severe and protracted drought it would undoubtedly be of value in conserving the soil moisture until the same result was attained by the growth of the vines themselves.

As to the value of tobacco-stem mulch, the experiment at North Haven presented some interesting facts, although,

* See Cornell Univ. Agr. Exp. Sta., Bull. 149, p. 720. 1898.

owing to the entire absence of plant-lice, nothing was learned regarding its efficacy in protecting the vines from those insects. Merely as a covering for the soil, tobacco seemed to be of even less value than marsh hay, and is, of course, much more costly. Weeds thrived with peculiar luxuriance where the tobacco was used. But, as a source of plant-food, the value of the tobacco became more and more apparent as the fruiting season approached. The whole field had received a liberal application of fertilizer* before the seed was planted, and this proved sufficient to maintain the vigor of the vines until the fruit was about half grown. On August 13th a visit was paid to the field and the appearance of the vines left nothing to be desired. The leaves were of a rich green color, indicative of perfect health, the vines completely covered the ground, and the fruit was setting in great abundance and growing very rapidly. Nine days later the whole field had a yellowish tone, and closer inspection of the vines showed that they were evidently suffering from lack of food. The larger leaves, especially those near the center of the hills, were of a pale green color, very different in tone from that which had characterized them nine days previously. Moreover, on these leaves were beginning to appear the circular brown spots marked with darker concentric rings which indicate the presence of the *Alternaria*. Only on the plots mulched with tobacco did the vines show their former vigor. These facts can only be explained on the theory of an insufficient, or rather, an ill-regulated supply of plant-food. As I have said, the fertilizer for the whole season was applied at the same time and before the seed was planted. Had the season been a dry one, or had the rainfall been evenly distributed throughout the summer, or had the soil been less liable to leach, this original supply of plant-food would doubtless have been sufficient to carry the vines through. But the actual conditions were quite the reverse of this. The fertilizer was applied on May 9th and at the time of planting; the seed was planted between May 14th and 23rd. The month of May was very rainy, heavy rains occurring on sixteen of the thirty-one days. Then followed a long period of great

* Canada wood ashes was applied broadcast, at the rate of half a ton to the acre, a week before the seed was planted, and, at the time of planting, each hill received a fork-full of compost consisting of three parts of barnyard manure and one part of tobacco-stems.

drought, beginning on May 28th and continuing, practically without intermission, except for three light showers, until July 4th. During July there were seven days of rain, and the month of August was characterized by a succession of very heavy thunder storms which did great damage on loose soils. Under these circumstances melon vines grew rapidly during June and made large demands on the fertility of the soil. These demands were increased when the fruit began to form, while simultaneously the heavy downpours of August, falling upon the loose, sandy soil, washed much of the remaining fertilizer down beyond the reach of the roots and thus decreased the already limited supply of plant-food. These conditions were aggravated by the facts that too many vines had been allowed to a hill and that the set of fruit was enormous. Four vines occupied each hill, and on August 22nd I counted as many as thirteen almost full-grown melons in one hill. To form this amount of fruit there must have been a demand upon the soil which, under the circumstances, it could not supply, and the vines began to show signs of starvation. Just here the value of the tobacco mulch began to be apparent. Soaked by the rains and undergoing a natural process of decay, the tobacco stems readily gave up to the soil all of their soluble constituents, which proved sufficient to carry the vines through. A similar effect was seen in the melon patch at Saugatuck. A case of tobacco stems had been left over from an experiment of the preceding year, and Mr. Wakeman, the owner of the field, having no other use for them, applied them liberally to twenty hills, early in July. The soil was closer and less liable to leach than the North Haven soil, so that the vines in general showed no evidence of starvation; nevertheless, those which were supplied with tobacco stems were plainly more vigorous and retained their vigor longer than any others in the field.

I am not prepared to recommend tobacco stems either as a mulch or as a fertilizer for melons, since the cost would be prohibitive, but I think that the facts above stated justify the following conclusion:

When melons are grown upon a loose, sandy soil, which is liable to leach, it is advisable to apply the fertilizer in small amounts and at intervals throughout the season, or until the spread of the vines makes tillage no longer practicable, rather than to make a single application of a large amount at the beginning of the season. The former method will be found to be of special advantage in a season characterized by repeated and heavy rains, and if more than two vines are grown in one hill.

As to the effect of fungicides upon the diseases of melons, the experiments are rather inconclusive. They were designed to test the resistance of the foliage and to protect the latter from the *Alternaria*. The fungus, however, failed to appear at all on the vines at Saugatuck, and at North Haven it appeared first about the middle of August, when the vines were in a half-starved condition. Whether it would have appeared at all if the vines had been in better general health is an open question, though the hills mulched with tobacco certainly showed less of the trouble than did the others.

Of the four fungicides used — Bordeaux mixture, potassium sulphide, sulphur, and Laurel green — sulphur was the only one which injured the foliage seriously. This was the third season that I had used this fungicide on melons, having conceived great hopes of it from its well-known efficacy in checking the mildew of so tender-leaved a plant as the rose, and from the excellent results which had attended its use on celery on various occasions. In 1896 I recommended it for melons on the farm of the Messrs. Meeker of Westport, and Mr. Meeker reported that it burned the plants. In 1897 I used it myself in an experiment with melons at Mr. S. B. Wake-man's at Saugatuck, and, although I noted that the vines on which it was used showed evidences of severe blighting or burning, I was not prepared to lay the whole blame upon the sulphur, since all of the vines were practically ruined by excessive rains before the fruiting season. The experiments of the past summer, however, leave no further room for doubt. At North Haven the first application was made on July 6th; at Saugatuck, on July 7th. These were repeated on July 15th and 16th respectively. On the 22nd and 23rd the vines were so badly burned that the treatment with sulphur was discontinued. At North Haven no further applications were made to these vines and later one of the rows recovered partially, but the other two were irretrievably ruined. At Saugatuck, where the injury was not so serious, potassium sulphide was substituted for the sulphur and the vines recovered their vigor in a measure.

The application of sulphur to the leaves of melons is not to be recommended. Although valuable as a fungicide, it has a decided tendency to burn the leaves.

The Bordeaux mixture used in both experiments was made

according to the 6-4-50 formula and was applied four times at North Haven—July 6th, 15th, and 22nd, and August 2nd. At Saugatuck the melons were less advanced, and five applications were made—July 7th, 16th, and 23rd, and August 3rd, and 16th. The potassium sulphide was used in the proportion of two ounces to five gallons of water, and the Laurel green in the proportion of one pound to ten gallons. All of these were applied on the same dates. No injury of any kind resulted from the use of either the potassium sulphide or the Laurel green, but the vines sprayed with the Bordeaux mixture of full strength showed indications, after the third treatment, that the mixture was too strong; for the subsequent treatments it was made up on the 5-5-50 formula and diluted, before use, to half that strength. (See p. 266.) This proved perfectly satisfactory.

Bordeaux mixture (containing not more than three pounds of copper sulphate to fifty gallons of water), Potassium sulphide, and Laurel green are safe fungicides for use upon melon vines.

As to the efficacy of these fungicides in protecting the vines from fungous attack but little can be said. The only disease which affected them very seriously was the bacterial wilt. This appeared shortly after the runners began to grow rapidly, and continued throughout the season. It is worthy of note that at no time were any predaceous insects found in connection with this bacterial disease, although, taking the check rows as a fair sample of the field, the disease at North Haven destroyed almost thirteen per cent. of the vines, and at Saugatuck almost three per cent. At each spraying the vines were carefully examined and those showing the wilt wholly or in part were immediately pulled up and removed from the field.

The following is the record of this operation:

NUMBER OF WILTED PLANTS.		
	At North Haven.	At Saugatuck.
In Bordeaux rows,	3.	3.
Check,	5.	0.
In Potassium sulphide rows,	8.	1.
Check,	4.	4.
In Sulphur rows,	?	2.
Check,	10.	0.
In Laurel green rows,	15.	2.
Check,	9.	1.

It is evident that no conclusion can be drawn from these figures, unless it be that fungicides are useless in combatting the bacterial wilt of melons. If this be so, it is only in line with what we know of the bacterial diseases of other plants. They do not readily succumb to fungicides.

It is probable that the susceptibility of melons to contract the bacterial wilt is unaffected by the fungicides commonly used against fungous diseases. Removing and destroying all wilted vines is the only practical method of preventing the spread of the disease.

Observations on the spread, at North Haven, of the leaf disease caused by the fungus *Alternaria Brassicae* were convincing as to the efficacy of both Bordeaux mixture and potassium sulphide as preventives. The vines sprayed with each of these fungicides remained absolutely free from the *Alternaria*, while the characteristic brown blotches of the fungus made their first appearance, about the middle of August, on all of the corresponding check rows and increased in number throughout the fruiting season, damaging the vines to a considerable extent. It was noticeable, however, that the fungus appeared simultaneously with the first indications of the starved condition of the vines, none of the check rows, owing to an oversight, having received the tobacco mulch. This fact, coupled with the equally significant absence of the disease on the Saugatuck melons which at no time showed any sign of a lack of plant-food, would seem to indicate that the *Alternaria* attacks only vines which have been weakened by other causes.

Dilute Bordeaux mixture and Potassium sulphide may both be regarded as efficient preventives of the blotching of melon-leaves by the fungus *Alternaria Brassicae*, var. *nigrescens*. There are decided indications that vines thoroughly nourished and otherwise well cared for will not ordinarily suffer from this trouble.

As to the value of Laurel green, the results at North Haven are unfavorable. The rows sprayed with it began to be blotched at the same time and to about the same degree as the check rows. The Laurel green used was too coarse to remain in suspension even as well as Paris green. Only while vigorously stirred could the mixture be evenly distributed. This is an objection to its use in a spray, no matter how effective it might prove when suitably applied.

MILDEW OF LIMA BEANS.

BY WM. C. STURGIS.

In the Annual Report of this Station for 1897, p. 165, occurs the following statement: "Much can be done by the grower, apart from the application of fungicides, to lessen the susceptibility of lima beans to mildew. The selection of well-drained land and a light soil is important, but, above all, care must be taken, by reducing the number of vines in a hill and by planting the poles erect, to insure conditions as little favorable as possible to fungous disease." With the co-operation of Mr. S. B. Smith of East Haven, upon whose land the spraying experiment of last year was conducted, it was planned to test the difference between thick planting and thin planting, and between upright poles and slanting poles, as regards the prevalence of mildew. Four rows, each comprising thirty-six hills, were selected near the center of a large field of beans. On the first row the poles were set upright; on the second they were set slanting in pairs, so that the tips of the poles in each pair were together, on the third upright and on the fourth slanting. The first three rows were divided into sections of six hills each, and after the beans were well started above ground each hill was either thinned out or increased by transplanting, so that, beginning in the first section with one plant to a hill, the hills in each succeeding section contained one more plant than those of the preceding one. Thus the crop from the three rows would show the comparative results, as regards the yield, of having from one to six plants to the hill; and also any advantage, as regards the prevalence of mildew, which might accrue from planting thinly and preventing the excessive crowding of the vines at the tops of the poles. The fourth row was included merely as a check. It was set, according to the usual custom, with slanting poles, and the hills throughout contained an average of two or three plants. No spraying was done during the course of the experiment, since the latter had in view solely the connection between the prevalence of mildew and certain methods of culture, and it was therefore undesirable to check the possible spread of the mildew by the use of Bordeaux mixture, as was done last year. A similar experiment, though on a much smaller scale, was conducted on the Station grounds.

During the winter much time and labor had been expended in the endeavor to unravel the question as to how and where the mildew succeeded in passing the winter. With this end in view a quantity of pods and portions of vines completely covered with the fungus had been gathered the previous autumn and placed out of doors where they would be exposed to the weather without being disturbed. Eight months later this refuse was brought into the laboratory and examined with the utmost care for resting-spores, a perennial mycelium, or any other form in which the fungus might have been perpetuated. Through the kindness of Mr. A. N. Farnham of Westville, I also secured a large quantity of refuse from a mildewed crop of beans which had lain in the field all winter, and this was carefully examined. In neither case was there found any trace of a vegetative or reproductive body which could be even remotely associated with the *Phytophthora* causing the mildew. The old pods were a veritable fungus-garden, but all of the species observed were common saprophytes such as species of *Fusarium*, *Alternaria*, *Macrosporium*, and the like.

Failing in this search and yet feeling sure that somewhere in that mass of refuse there must at least be the living mycelium of the *Phytophthora* awaiting only a favorable opportunity to become again active, this refuse was used as a mulch for the beans which had been planted at the Station. It was spread thickly upon the ground before the beans had started, and the latter were allowed to come up directly through it.

Finally, from the pods contained among this refuse, I succeeded in collecting a score or so of fairly sound beans which were planted in a separate row with the hope that one or two might germinate, notwithstanding the winter's exposure, and throw some light on the source of infection. It seemed reasonable to suppose that if the mildew passed the winter in a dormant condition in the beans themselves, then the plants produced from such beans would inevitably become mildewed early, providing that the weather were favorable to the development of the fungus, while if the latter were dormant in the old pods and vines, the forcing of young plants to grow up through a mulch of such refuse would certainly result in an early and disastrous attack.

That everything conspired to favor such an attack during the past season, was evident from the great damage which was caused by the mildew on the Smith farm at East Haven. The

fungus made its appearance there on August 5th, and by the 26th of that month over fifty per cent. of the pods were destroyed and there were no prospects of any further development of pods. The beans were on rather low, moist ground, and the weather during August was, on the whole, damp, close and sultry. Notwithstanding this, hardly a trace of the mildew appeared on the vines at the Station. Many of the beans were destroyed by field mice shortly after being planted, but a fair stand was secured; the vines grew well and produced perfectly sound pods until almost the close of the season, when some mildew appeared. The mulch of refuse from a mildewed crop had practically no effect on the vines which grew up through it, a fact which would indicate that such refuse remaining on the field is not, as would naturally be supposed, a menace to the crop of the next season. Of the beans collected from the refuse, only one germinated, but that one produced a vigorous, thrifty vine which bore a full crop of perfectly sound pods. Apparently, then, the propagative power of the mildew does not reside in the diseased seed. No clue was obtained from these experiments as to the important question of how and where the mildew is propagated from one season to another. The latest researches along this line, in connection with the related potato mildew, *Phytophthora infestans*, prove conclusively that that fungus passes the winter in the stored tubers, in the form of mycelium,* and analogy would lead one to suppose that in the same way the bean-mildew remains dormant in the diseased vines, pods, or seeds. As has been seen, however, neither observation nor experiment have thus far given any indication that such is the case.

The extensive experiment at East Haven was designed to test the comparative effect upon the prevalence of mildew and upon the total yield, of close and open planting and of upright and slanting poles. The results are of interest, but are not wholly conclusive. As regards the total yield, it was very seriously diminished by the mildew and this diminution was not proportional to the varying number of plants to a hill, for the reason that the sections containing the smallest number of plants were on the lowest ground and were first and most seriously attacked by the mildew. The crop on these sections, therefore, was proportionately less than it

* Ludwig Hecke, in Journal für Landwirtschaft, XLVI, pp. 71-74 and 97-142. 1898.

would have been if the only factor concerned had been the smaller number of vines to a hill. Moreover, on the upper sections where the hills each bore five or six plants, it was impossible to bring so many plants to maturity, since three or four were always more vigorous than the rest and consequently survived, while the weaker ones were dwarfed and often produced no fruit whatever. It appears safe to assert that it will not pay to attempt to grow more than four and probably three lima-bean plants to a hill.

Bearing these facts in mind we will consider the records of the various plots. Gatherings were made on August 5th, 12th, 20th, and 26th, and September 1st. At each gathering all of the marketable pods were picked and a record kept of the total number of pods and the number mildewed. At the final picking, on September 1st, all of the pods two inches or more in length were gathered, as the mildew had infested the fruiting tips of the vines to such an extent that there was no prospect of a further development of pods. The following record, therefore, represents very accurately the total yield of the vines and the percentage of mildewed pods for the whole season, on the experimental rows:

ROW A—POLES UPRIGHT.

Number of vines to a hill, .	6	5	4	3	2	1
Total number of pods, . .	478	595	639	631	528	417
Number of mildewed pods, .	236	228	332	315	192	248
Percentage of mildewed pods, .	49%	38%	52%	50%	36%	59%

ROW B—POLES SLANTING.

Number of vines to a hill, .	6	5	4	3	2	1
Total number of pods, . .	540	445	390	494	478	453
Number of mildewed pods, .	267	211	193	227	253	218
Percentage of mildewed pods, .	49%	47%	49%	46%	53%	48%

ROW C—POLES UPRIGHT.

Number of vines to a hill,	6	5	4	3	2	1
Total number of pods,	624	564	567	632	350	275
Number of mildewed pods,	308	361	289	299	168	124
Percentage of mildewed pods,	49%	64%	50%	47%	48%	45%

A glance at these tables shows that in this instance the position of the poles has had no effect whatever upon the prevalence of the mildew. On the three sections planted with six vines to a hill, where we would naturally expect to find a decided difference owing to the excessive crowding of the growth at the top of the poles, no difference is apparent, while upon the section planted with a smaller number of vines the percentages of mildewed pods permit of no deductions regarding upright *vs.* slanting poles. The same is true in a measure regarding the effect, on the mildew, of thin *vs.* thick seeding. The highest percentage of mildew in row A occurs where only one plant was allowed to a hill. In row B it occurs where two plants were allowed, and in row C where five plants were allowed to grow in one hill.

The total yield was so seriously diminished by the mildew that no inferences can be drawn from the figures as to the comparative value, in this respect, of upright and slanting poles, but it is interesting to note, regarding thin *vs.* thick seeding, that increasing the number of vines in a hill does not increase the yield proportionately. In this respect two or three vines to a hill show as good a record as do five or six. In an ordinary season two vines to a hill would be an ample allowance. The past season was an extraordinary one in that the weather was exceptionally conducive to the spread of the mildew. The loss of over fifty per cent. of the pods and the practically complete destruction of the crop by September 1st, only four weeks after the first appearance of the mildew, shows the severity of the attack, and it is very probable that under such conditions no merely cultural methods would ever suffice to prevent or even to lessen the destructiveness of the fungus. One other fact served in a measure to vitiate the results. As stated above, the field where the beans were grown sloped downward slightly from north to south. A marshy piece of land adjoins the field on the south,

and in rainy weather the soil is so wet at that end that it is difficult to secure a stand of beans. The experimental rows ran north and south so that the soil at the lower end of every row was decidedly more moist than that at the upper end. This had a marked influence on the mildew, causing it to appear earlier and with more severity on the more thinly seeded sections where it was expected to be less severe. That this caused an exceptionally high percentage of mildew on these sections and therefore tended necessarily to lead to erroneous conclusions regarding the value of thin seeding is shown by the record of row D, which was a normal field row, set, as usual, with slanting poles and bearing an average of two or three plants to a hill. This row yielded, on August 12th, a total of 305 pods, of which nineteen, or six per cent., were mildewed; the mildewed pods occurred only on the lowest six hills. On August 20th the lower half of this row yielded 287 pods, of which forty-four per cent. were mildewed, while the upper half yielded 272 pods, of which only twelve per cent. were mildewed. Later, when the mildew was at its height, there was no appreciable difference between the upper and lower portions of this row, but it is very evident that the wetness of the soil in the lower portion of the field exercised an important influence upon the inception and spread of the trouble. If this had been foreseen the experimental rows would have been run east and west and we should have looked for a marked advantage from thin seeding, an advantage which, under the circumstances, was offset by the more favorable conditions existing for the spread of the mildew where thin seeding was tried.

I am confident that the loose, dry soil upon which the beans were planted at the Experiment Station was the chief factor in preventing the appearance of the mildew until very late in the season. All other conditions were as favorable to it as on the Smith farm, and every means, short of direct infection, was used to induce an attack. It would be useless to attempt to draw any conclusions from these experiments.

They serve, however, to emphasize the importance of selecting high, well-drained land for the culture of lima beans, and they indicate that a wet soil tends to induce the spread of the mildew in a degree which no cultural methods will wholly counteract.

PRELIMINARY NOTES ON TWO DISEASES OF
TOBACCO.

BY WM. C. STURGIS.

For the last three years my attention has been repeatedly called to a peculiar disease of growing tobacco, and I have been urged to investigate it with the view of ascertaining its cause. The pressure of other work and the distance of the Experiment Station from the principal tobacco regions of the State have prevented my giving to this matter the attention which it deserves, and the following notes are compiled largely from the published works of foreign investigators, supplemented by such information as I have been able to gather from the growers and from personal observation. In this connection I wish to express my indebtedness to Mr. W. K. Ackley of East Hartford for his valuable assistance in the way of supplying information and in affording every facility for a study of diseased tobacco in the field.

THE SO-CALLED "CALICO" OF TOBACCO.

This disease of tobacco is very common in certain seasons and in certain portions of the tobacco region about Hartford. It may make its first appearance either in the seed-bed or in the field. In the former case the young plants, when they are from one to six inches high, begin to show a mottled appearance of the leaves, at first visible only as an almost imperceptible pale green color of the tips of the leaves, but soon arresting attention by the spread of this pale color, in blotches, all over the leaf surface, the contrasting shades of green being very noticeable. Such plants are of course discarded when transplanting to the field is begun; nevertheless, the same disease may appear later in the field, sometimes within a week of transplanting and sometimes not until after the plants have been topped and suckered. When a plant is attacked in the field it soon becomes a noticeable object, even from a distance. It is usually smaller than its neighbors, it does not present the healthy, dark green color of a sound plant, the leaves are narrow and are inclined to stand up stiffly, and on closer inspection the peculiar mottling of the leaves is very distinct. The pale color, first visible at the tips of the leaves, gradually

progresses downwards, following with more or less regularity the course of the veins. The paler tissues grow less rapidly than those of the darker portions, so that the mottled appearance becomes intensified by the thickening of the darker areas and the leaf surface presents a blistered appearance. Another characteristic of a diseased plant is the tendency of the leaves to curl downward at their margins, owing to the fact that the growth of the marginal tissues is checked. From this time on the plant is worthless and is generally removed. If allowed to remain, the paler portions of the mottled leaf lose their green color, and the whole leaf becomes yellow and sprinkled over, especially toward the tip, with small circular spots where the tissues are bleached, dead, and brittle. Sometimes the leaf, in the later stages of the disease, takes on a uniform reddish-brown color. The disease, in its progress, resembles a process of ripening in which every phase, from the first indistinct mottling characteristic of a fully ripe leaf, to the final brown color of the leaf when cured, is represented in an intensified form and a brief period of time.

What is recognized among experts as true calico makes its appearance early, in the seed-bed or the field; attacks, at first, the middle and lower leaves; spreads from them to the upper, younger leaves; and usually is at its worst before the time for topping. At that time, or when the flower buds begin to form, especially if a period of cold, damp and cloudy weather is followed by hot, clear weather, some plants in a field show what growers call "mottled-top." The topmost leaves of the plant become mottled, but this appearance is finer and less pronounced than in the case of true calico. The leaves show the same tendency to stand erect, but are very susceptible to hot sunshine, drooping under it so conspicuously that a "mottled-top" plant can be readily recognized at a distance of several rods. What the ultimate fate of such plants is I am unable to say from personal observation, but it is not regarded as serious, since the affected portion is removed when the plants are topped and it does not spread to the remainder of the plant. I am also assured by certain experts that, under favorable conditions, a "mottled-top" will recover, though from the nature of the case it is only by an oversight in topping that it is given an opportunity to do so. One more point regarding "mottled-top" is worthy of mention. Leaves affected in this manner are supposed to be tougher in

texture than sound leaves, and, as a matter of fact, a "mottled-top" leaf which has become wilted can be crumpled in the hand without injury; but this is evidently merely the toughness which characterizes any tissue which has become flaccid through the withdrawal of water, and cannot be considered as a symptom of disease.

From careful observation of plants affected with "calico" and with "mottled-top," I have been unable to escape the conclusion that they are merely two phases of one and the same trouble. When it affects the plants early, whether in the seed-bed or in the field, and attacks severely the larger middle and lower leaves, it is called "calico"; but when it appears later in the season and produces only mild symptoms in the younger, top leaves, it is called "mottled-top." I may add that many growers are inclined to accept this hypothesis.

We may now pass to a consideration of some of the conditions under which calico develops. That it occurs throughout the tobacco fields of Hartford county is an undoubted fact, but it is equally certain that it is far more serious in some localities than in others. Thus, on the western side of the Connecticut River calicoed plants are seldom if ever seen in the seed-beds, and they occur only sporadically in the field. I have never seen a field of tobacco really seriously affected with calico in that region. The suckers, it is true, often show calico, but that is a condition very commonly occurring everywhere. On the eastern side of the river, particularly in the townships of East Hartford and South Windsor, calico is a very serious trouble almost every year. I have seen fully ten per cent. of the plants destroyed by it in a single field, and the damage seldom falls below one per cent. It is of interest, therefore, to compare the conditions prevailing on the two sides of the river.

Soil. — On the west side the best tobacco fields consist of a loose, deep, sandy soil, easily worked and fairly retentive of water. As a rule these lands, before being brought under cultivation, were covered with a second growth of white birch after having been denuded of the original forests of white pine. The surface of the soil crusts over after a rain, but the soil itself is rather loose in texture and does not bake or pack, hence it acts as a good conductor of heat and its temperature becomes readily adjusted to that of the atmosphere. On the east side, particularly where calico prevails, the soil contains

a larger percentage of silt or clay, hence it is more retentive of water, absorbs and gives off heat much less rapidly, requires constant tillage and, after a rain, bakes hard. When packed and slightly moistened, its surface has a slimy feel and becomes quickly covered with a coating of green algae. The difference between these two soils, especially as regards their susceptibility to changes of temperature, is worthy of note. It should also be noted, however, that in some localities on the east side the soil approaches in character that of the west side, being lighter and sandy, and that, in the opinion of certain growers, these localities are quite as liable to produce calicoed tobacco as are the clay soils. Upon this point further information is most desirable.*

Variety of Tobacco. — Few plants are more profoundly influenced by the character of the soil in which they grow than is tobacco. As a rule a close, heavy soil is best adapted to a large, rather coarse tobacco, curing to a dark color, while a lighter soil is suited to varieties with a smaller leaf, thin and silky in texture and curing to a bright color. The differences between the soils on the east and west sides, therefore, have their counterpart in the varietal differences between the tobaccos raised. On the west side, Havana is grown exclusively; on the east, seed-leaf; and the prevailing theory is that these cannot be reversed with profit.

Method of Culture. — The construction and the sowing of the seed-beds, as well as the general methods of transplanting and growing the crop, are essentially the same on the two sides of the river, and call for no comment.

Manuring. — In this particular the custom prevailing on the one side differs materially from that on the other. On the east side, natural manures are used very largely; on the west side, fertilizer-chemicals form the staple, if not exclusive, supply of plant-food. Of course there are exceptions on both sides, and individual judgment has led to numerous experiments with fertilizers, but the usual custom is as above stated, although on the east side there is a growing tendency to supplement the liberal application of stable manure with the sulphates of potash and ammonia, dissolved bone-black, etc.

Selection of Seed. — Usually the large growers raise their

* Those interested in this matter should consult U. S. Dept. Agric., Div. of Soils, Bull. 11, entitled "Tobacco Soils of the United States."

own seed year after year. Where calico prevails, the custom is to raise and use seed from sound plants for a period of three years, and then to secure a supply from some neighboring grower. This custom is of course based upon the supposition that calico may be transmitted through the seed, a supposition which, as we shall see later, is erroneous.

These very brief notes are sufficient to show that the principal points of difference between the conditions under which tobacco is grown on the east side of the Connecticut River, where calico is abundant, and on the west side, where it is very seldom, if ever, a serious trouble, are three in number; first, a marked difference in the texture of the soil; secondly, a consequent difference in the variety of tobacco which can be profitably raised; and thirdly, a difference in the substances used as sources of plant-food. We may eliminate the second difference, since it is directly dependent upon the first and since it is no explanation of the cause of calico to say that seed-leaf is more susceptible than Havana.

The essential differences then, are found in the soil and in the fertilizers. Which of these, if either, is accountable for calico? Before attempting to answer this question it will be of interest to note the results of certain observations and investigations which we have made on calicoed tobacco. External injuries which, either as cause or symptom, are connected with a plant disease, may be due to the attacks of predaceous insects or of parasitic fungi, to the invasion of the tissues by bacteria, or to causes of a physiological nature whereby the normal functions of the plant become deranged and wilting, yellowing, or spotting of the foliage results. Repeated and careful microscopic examination of the tissues of calicoed tobacco-plants precludes the theory of insect-injury. Calicoed leaves are not only free from insects themselves, but they show no sign of punctures or other indications of insect-attack. The external tissue of the stalks also shows no injury attributable to insects. Occasionally there are found in the tissues of the roots a few nematodes or eel-worms, but they are as frequently found in the root-tissue of sound plants.

It may be said with an equal degree of certainty that calico is not due to fungi. In the last stages of the disease, when the affected leaves have become brown and spotted, the dead tissues are frequently invaded by molds, but the latter are only such as occur commonly on any dead vegetable

substance, and in the earlier stages of the disease there is no trace of any fungus upon or within the tissues of the leaf. Search has also been made in the tissues of the stem and root of calicoed plants for fungi which are known to invade the water passages of some plants and, by their rapid growth, prevent the upward passage of water, and thus produce a wilting of the plant, and finally its death. No such fungus has been found.

As to the presence of bacteria in the diseased tissues, I cannot speak with any certainty. Direct microscopic observation is not to be relied upon, since the contents of the cells are so dense that they would effectually mask the presence of bacteria, unless the latter were present in great abundance; this they certainly are not. The only sure method of determining the presence or absence of bacteria is by means of cultures from the diseased tissues, and this I have not yet attempted. If the disease is caused by bacteria it would seem strange that it is not apparently contagious. It sometimes happens that where the plants are set by machine, two plants are dropped in the same spot. In such cases I have myself seen, and experts tell me that it is a common occurrence, that one of the plants becomes calicoed while the other remains perfectly healthy. In re-setting calicoed plants there is no evidence to show that the fresh plant is at all more liable to become calicoed from having been set in the spot previously occupied by a diseased plant. Moreover, the fact that suckers from a perfectly sound plant are very liable to calico and that a plant or stub bearing calicoed suckers may have shown no sign of the trouble, militates against the theory of bacterial infection. Finally, if the disease is caused by bacteria there would be a strong probability that seed from a calicoed plant would have a tendency to reproduce the disease. This, however, does not seem to be the case, as the following experiment shows:

In the spring of 1897, wishing to follow the course of calico continuously in the field, I secured from the seed-beds of Mr. Ackley of East Hartford twenty seedlings showing calico and, from the same bed, twenty apparently healthy seedlings. These were brought to the Station and set in two parallel rows in the garden. They were set too close together, the soil was not adapted to tobacco, only a very small amount of fertilizer was added to it and the plants received very little attention in the way of tillage. With one exception, all of these forty

plants were badly calicoed within six weeks. The exception was one of the originally healthy plants. The calicoed plants were dwarfed and the trouble ran its course with great energy; nevertheless, most of the plants flowered and ripened an abundance of seed. This seed was gathered and, in the following spring, after being sprouted, was sown in flats in the green-house. Of the hundreds of seedlings thus raised not a single one showed a sign of calico in the flats. Thirty seedlings were transplanted and set in a row in the Station garden; the soil in this place had received a dressing of barnyard manure and ten of the plants were given in addition about two bushels of manure, ten more received a handful of mixed chemical fertilizer dropped in the bottom of each hole before setting the plants and the remaining ten were planted without any additional fertilizing. All of the plants, especially those provided with an abundance of plant-food, showed great vigor and remained perfectly healthy. Meantime, from the same lot of seedlings, a dozen were sent to Mr. Ackley, who set them in a warm corner near the barn where they received the drainage from the barnyard. These also failed to show any sign of calico and formed plants of extraordinary size and vigor. It would seem apparent, therefore, that calico is not communicable through the seed.

Although it is by no means proven that calico is not a bacterial disease, and although the evidence that it is not so is entirely inferential, yet the facts above noted certainly create an impression that we must look elsewhere than to bacterial infection for the cause of calico.

We have thus excluded from the list of possible causes the attacks of insects, whether above or below ground, and of parasitic fungi on or within the tissues of diseased plants; the case against bacteria is doubtful, and there remains only the question of some physiological disturbance. Such a disturbance may arise as the result of artificial injury whereby the normal functions of the plant are hindered or arrested, or it may be due to abnormal natural conditions producing a similar result. In the former case, if the leaves and stalk are normal and uninjured, attention is at once directed to the root.

The opinion is often expressed with regard to calico that it is due to an unnatural twisting of or injury to the roots of the seedling in the process of transplanting, or to setting the plant over a stone or other obstruction which prevents the normal

growth of the tap-root. It is evident, however, that this theory fails to explain the existence of calico in the seed-bed, and, furthermore, the examination of the root-systems of scores of calicoed plants in the field, and a comparison between them and those of sound plants, shows no essential differences except such as are correlated with the dwarfed habit and weakened vitality of the calicoed plant.

Secondly, disturbances in the functional activity of a plant due to abnormal natural causes may be connected either with the soil, including its texture, composition, and contents, whence the plant draws its food and water; or with the atmosphere from which the plant derives the carbon for building up its framework and into which it transpires the excess of water absorbed by the roots.

As to the soil and its composition, it is naturally and primarily considered as a vehicle of plant-food supply. In this connection, it will be remembered, we noted as one of the essential differences existing between soils upon which calico is common and those upon which it is comparatively rare, that the bulk of the plant-food is supplied in the former case by stable manure and in the latter by fertilizer chemicals. Are we justified in concluding that here at length we have found the essential factor in the prevalence of calico? There have not been a sufficient number of critical experiments along this line to form the basis for a trustworthy answer to this question, nevertheless there are facts which have a direct bearing upon it. That calico is not due to a lack of plant-food is to be inferred first from the fact that quite as much plant-food is applied to the soil in one case as in the other, and secondly from the fact that calicoed plants occur here and there, without regularity, among the sound plants in a field liberally and evenly supplied with a complete plant-food. An inadequate food-supply would hardly become apparent in this sporadic manner. Moreover, the opinion of experts in raising tobacco is directly opposed to the theory that stable manure is responsible for calico, and their opinion is that of intelligent, practical men, who have experimented along this very line with the view of checking the disease. It is more than doubtful if calico is due to a lack either of plant-food in general, or of any one in particular of the essential elements of plant-food,—nitrogen, potash, or phosphoric acid. The case is somewhat different as regards lime,

—a substance which, on certain soils, is necessary to the best plant-growth. Lime may act beneficially in a number of ways. Occasionally it may enter directly into the economy of the plant, but usually its value lies in its mechanical and chemical action upon soils containing a large percentage of clay, undecomposed vegetable matter, or zeolitic silicates. In the case of most clayey soils, it tends to bind the finest particles together, thus making the soil more porous; where vegetable matter abounds, this is decomposed and made available by lime; in the case of zeolitic silicates, lime unites with them and liberates potash, ammonia, and other valuable constituents of plant-food, which thus become available.

Acting on the presumption that on the close, clayey soil of the tobacco fields of East Hartford the application of lime might be followed by good results, one of the largest tobacco-growers in that neighborhood was advised to try it. In accordance with this advice, he applied last fall on a portion of his land two and a half barrels of slacked lime per acre, and supplemented it the following spring by an application, broadcasted and harrowed in just before setting, of a barrel and a half of lime. The experiment was rather roughly planned and conducted, and no exact record of the results was kept, but the experimenter reported that no appreciable benefit resulted so far as the prevalence of calico was concerned.* It is highly desirable that this experiment should be repeated under better conditions, but meanwhile we may presume that whatever benefit results from the use of lime will be due, more to its effect upon the texture of the soil, than to supplying an element of plant-food which in all probability is not deficient.

A consideration of the soil in its mechanical aspects bears a close relation to certain facts connected with atmospheric conditions and the effect of the latter upon plant-life. To this consideration the question of the cause of calico has now been narrowed down, if we except the possible theory of bacterial infection. We have frequently called attention to the fact that a period of hot sunshine following a period of cool, cloudy weather may have a very deleterious effect upon a plant by

* Since the above was written I have heard of one well-authenticated case in which a heavy application of lime to the clayey tobacco-land of East Hartford was followed by a very marked decrease in the amount of calico usually seen.

causing such rapid evaporation of water from the leaves that the roots are unable to supply the demand. The effect of such a disturbance of equilibrium will become apparent in a wilting of the plant and, if long continued or repeated, will cause a diminished rate of growth and possibly the death of certain tissues situated at a distance from the source of supply and nourished only by the fine terminations of the veins; such tissues are situated at the tips and edges of the leaves, hence the tips will show signs of a lack of water and the margins, checked in their growth, will tend to become incurved. These symptoms will be the more marked the more sudden and violent are the atmospheric changes. Moreover, a plant of rank growth and succulent tissues will be more seriously affected than one in which growth is slow. Finally, the effect will be more serious if the soil is fine and close in texture than if it is loose and porous, since in the former case it is more retentive of moisture and therefore a poorer conductor of heat. In such a soil, the roots, if once chilled and their absorptive capacity diminished, as happens when the weather is cool, damp and cloudy, recover that capacity only as rapidly as the soil-temperature approximates that of the atmosphere; consequently, a plant growing in such a soil might be irretrievably ruined by a sudden access of sunshine long before the roots, buried in the cold, non-conductive soil, could so far recover their capacity for absorbing water as to supply the suddenly increased demand on the part of the leaves.

So much by way of theory. What have we by way of facts in the case of calico?

First, the general appearance and behavior of calicoed plants bears the closest resemblance to that of plants affected by the conditions above described. No one could observe a calicoed tobacco-plant and compare its appearance with that of tomato-plants forced to active growth in the greenhouse and affected as described in the Annual Report of this Station for 1896, pp. 232-234, without concluding that the two diseases were attributable to very similar causes.

Secondly, the tobacco-plant, like the tomato, but in a still higher degree, is of extremely rank growth, while the value of the leaf depends largely upon the delicacy of the tissues composing it; hence the plant is intolerant of sudden atmospheric changes and becomes more so the more those characters which give it commercial value are emphasized.

Thirdly, the calico of tobacco is prevalent in a district characterized by a close soil of fine texture, which packs hard, retains moisture, and is a poor conductor of heat; it is less common on loose, porous soil devoid of clay.

Fourthly, the disease is sporadic in its nature, attacking one plant and leaving the next one untouched; this is only what might be expected when we consider the differences which are known to exist between individuals of the same species and growing under identical conditions, as regards susceptibility to external conditions. A damper spot in the soil, a slightly unfavorable position of the roots, the close proximity of a stronger plant, an exceptional delicacy of texture or of that intangible quality which we call physical constitution,—any or all of these causes might be sufficient to predispose a plant to calico while its neighbor remains perfectly healthy.

Fifthly, the fact that suckers from the butts of plants which have been cut, are disposed to calico, may possibly be correlated with the fact that these suckers are produced at a season characterized, in this climate, by sudden atmospheric changes, that they are composed of rapidly growing tissue and are directly exposed to the full force of the sun, and that the soil is no longer kept open and porous by means of tillage.

Sixthly, there is a vague impression, hardly amounting to a theory, on the part of many growers of tobacco, that the attacks of calico are not so severe in places where the plants are in a measure shaded by trees, as where they are fully exposed.

Lastly, a number of experts in tobacco have, irrespective of any theory of mine, expressed to me their decided conviction that serious outbreaks of calico occur only during periods of sudden and marked atmospheric changes.

SUMMARY.

1. The peculiar appearances known as "calico" and "mottled-top" of tobacco are probably symptoms of one and the same disease. The former may occur very early in the life of the plant, even in the seed-bed, and usually attacks first the older leaves; the latter occurs later, is less pronounced, and affects only the topmost leaves.

2. The disease occurs abundantly in some localities, notably on the close, clayey soils on the east side of the Connecticut river; sparingly in other localities, where the soil is open and porous.

3. The disease is not contagious. As to its infectiousness, no direct statement can as yet be made.

4. It is not caused by predaceous insects, nematodes, or parasitic fungi.

5. Bacteria have not been seen associated with the disease, but no critical method for their isolation or culture has been applied and therefore the question of their influence cannot at present be answered. The facts observed, however, are not favorable to the theory of bacterial infection.

6. The disease is not inherent in the seed. Seed from badly calicoed plants may produce perfectly sound plants and *vice versa*.

7. It seems probable that the disease is purely a physiological one, caused primarily by sudden changes of atmospheric conditions which disturb the normal balance between evaporation of water from the leaves and its absorption by the roots, and secondarily by soil-conditions which prevent the speedy restoration of that balance. This supposition is supported by numerous facts.

Preventive Measures. These must, of course, be regulated by the opinion which is formed as to the probable cause of the disease. If it is bacterial, the only means of eradicating it from the field is by pulling, removing from the field and burning, every plant showing the least sign of the disease. In case it arises primarily in the seed-bed, the latter must be removed to fresh, uncontaminated land. A still more effective precaution in the latter case, would be to remove the soil, to the depth of a foot, over the space to be occupied by the seed-bed, and to replace it with soil thoroughly sterilized by being baked on a bed of sheet-iron placed over a hot fire, in much the same way as the sand used in the making of concrete walks is treated. If, on the other hand, the disease is a physiological one, there are two lines along which experiments might be conducted with fair hopes of success; first, the addition to the soil of some substance which will render the soil more porous and more permeable to heat; secondly, the protection of the plants, at critical seasons, from a sudden access of sunshine. To accomplish the first-named purpose lime will probably be in many cases, the cheapest and most effective agent. The quantity necessary and the best time to apply it are matters which can be settled only by experiment. To accomplish the second object, it might be possible and practicable to adopt some such device as that used by tobacco-growers in Florida. It consists of long mats composed of slats fastened together with twine. Wires are stretched across the field at intervals and upon these the mats are spread. The slats have narrow spaces between them so that they allow of the passage of rain and sun-

light, while at the same time they screen the plants from the direct rays of the sun. It is said that tobacco grown under these conditions is exceedingly fine. We hope, another season, to investigate these matters thoroughly.

THE SO-CALLED "SPOTTING" OF TOBACCO.

If that can be called a disease which is characterized by symptoms such as tobacco-growers desire to see in moderation, which enhance the market value of the leaf and which can be induced artificially with profit, then the "spotting" of tobacco comes under this head. It is a peculiar disease, never very common, not confined to any one locality and not characteristic of any special soil. What its earliest stages are I am unable to say, inasmuch as it is impossible to predict when it will occur and therefore to be on the watch for its first appearance, and, furthermore, because it only becomes noticeable when well advanced. As I have seen it in the field and in specimens sent to the Station, it is signalized by the presence on the leaf of small circular spots. These usually occur in the greatest number at or near the tips of the leaves and, at first, are yellowish in color and somewhat irregular in outline. Later they take on a circular form and become marked off from the surrounding tissue by a narrow border of a darker color. The tissue within this border finally dies and becomes almost white, but, except in severe cases, it does not break away from the leaf. A leaf so affected looks as though it had been sprinkled over with some caustic substance which has killed the tissues without disintegrating them. It bears a close resemblance also to the "leaf-spot" caused on certain plants by the attacks of fungi. Sometimes the spotting is slight and the spots themselves are scattered evenly over the whole leaf-surface; in such cases buyers are willing to pay a higher price for the tobacco, spotted wrappers being in demand. The spot can be successfully imitated by spraying the ripening leaves with a caustic liquid, and, where this is well done, the tobacco also brings a higher price.

It is only when the spot invades practically the whole leaf and causes the breaking of the tissues that it does serious damage. I have repeatedly, but thus far unsuccessfully, attempted to discover the primary cause of this trouble both by consult-

ing the opinion of experienced tobacco-growers and by careful microscopic examination of the spots. Some say that it is due to particles of sand adhering to the leaves; others that it is caused by drops of water, which, acting as lenses, burn the leaf where they rest; but with regard to these theories it is sufficient to say that they have been put to proof in many attempts to produce the spot artificially, and have signally failed. Scores of the spots have been microscopically examined during the past three years without showing any evidence of the presence of fungi, insects, or bacteria. Nothing further, therefore, can be said regarding this trouble, nor would it have been considered worthy of mention at present were it not for its resemblance to a disease of tobacco which occurs in Europe and Asia.

FOREIGN INVESTIGATIONS UPON TWO DISEASES OF TOBACCO.

In 1885 Dr. Adolf Mayer, Director of the Experiment Station at Wageningen, Holland, published an account of a disease of tobacco to which he gave the name "Mosaik-krankheit," or Mosaic Disease.* This disease is characterized as follows: In from three to five weeks after setting, there appears upon the leaf-surface of plants, otherwise healthy, a mottled coloration in shades of dark and light green. The tissues of the darker portions become thicker and grow much more rapidly than the paler portions, so that an irregular wrinkling of the leaf-surface results. As the disease progresses certain of the paler and thinner portions of the leaf die out prematurely in a manner not altogether unlike that which is seen in fully ripe leaves, though to a much greater degree. When one leaf is diseased, all the younger leaves of the same plant also show the disease, but in correspondingly earlier stages. Frequently several diseased plants occur together in the field, but, quite as often, sound and diseased plants are irregularly distributed and a diseased plant never appears to be a source of contagion to those surrounding it.

From this description and the colored figures which accompany it, it is difficult to avoid the conclusion that the "Mosaic" of Dutch tobacco is the same as the "Calico" of Connecticut tobacco. As to the cause of the former, Mayer's

* Die landwirthschaftlichen Versuchs-Stationen, Bd. XXXII, p. 451. 1885.

investigations exclude the theories of a deficiency in the supply of plant-food; the attacks of nematodes; sudden changes of atmospheric and other conditions in the hot-beds, where the seedlings are raised; mechanical injuries to the roots in transplanting; the sudden change from conditions of long-continued high temperature, as in the hot-bed, to the cooler temperature of the field; the use of seed from diseased plants; and finally, the presence of parasitic fungi. But it was discovered that the juice of a diseased plant, when introduced into the mid-rib of a leaf on a sound plant, would reproduce the disease, the "period of incubation" being regularly ten or eleven days. Nevertheless, neither microscopic examination of diseased leaf-tissue, nor cultures from its sap, availed to show the presence of bacteria in connection with the disease. The infectious sap was filtered, but it still retained its virulence; if, however, it was passed through a double filter-paper, Mayer found that it lost its infectious character. Heating the sap for several hours at 80° C. had the same effect upon it.

Mayer thereupon concludes that (1) "The mosaic of tobacco is a bacterial disease from which, however, the infectious organisms have not been isolated. Their form and life-history is therefore unknown. (2) The contagiousness of the disease, by the artificial transfer of sap, has been proved with certainty. Under natural conditions no evident contagion, from one plant to another, occurs. Seeds of diseased plants can produce sound plants. (3) The spread of the contagion must be sought in the soil of the field or hot-bed, since certain fields, especially those in continuous use (for tobacco culture) are peculiarly subject to the disease. A case of the transfer of the disease by means of the-soil has never been proved."

Upon the basis of these conclusions, Mayer recommends the renewal of the soil in the hot-beds, rotation of crops, the removal of the stubs of diseased plants after the crop is harvested, and the use of fertilizer chemicals in place of stable-manure. Three years later, in a brief note, he records a case in which the renewal of the soil in a portion of a hot-bed resulted in the almost total elimination of the disease, while one quarter of the plants from hot-beds where the soil was not renewed were diseased.

We are not in a position to question these statements, but it is to be noted that the mere fact that sap from a diseased plant will induce similar symptoms of disease when injected into the

tissues of a sound plant is not, in itself, a conclusive proof that the cause of the disease is bacterial. Smith's researches upon peach-yellows have shown that a healthy tree budded from one affected with the disease will contract it, although there is not the slightest evidence that peach-yellows is a bacterial disease. The two cases are not precisely parallel since the energy of contagion in the case of yellows, resides, not in the extracted sap of the diseased tree, but in the vital cellular union between the diseased bud and the healthy stock; nevertheless, it serves as a general illustration of the fact above mentioned. But apart from this, Mayer's investigations must be regarded rather as circumstantial evidence than direct proof, since he has neither observed, nor succeeded in isolating, any specific germ.

Shortly after the publication of Mayer's observations, two Russian investigators described another disease of tobacco to which they gave the name of "Spotted Disease" (*Pockenkrankheit*).* This disease, according to these observers, appears in June, as white or brown spots of various shapes and sizes upon the leaves. They are sometimes simple specks, sometimes half rings, circles, or zig-zag lines following or crossing the veins. The first sign of the disease is the appearance of one or more shiny spots on the surface of the leaf. The gloss becomes gradually more pronounced and presently the tissues composing it collapse to half their normal thickness. Later these tissues become dry and brown or bleached, and sometimes separate from the surrounding tissues which remain apparently sound. The time required for a leaf to become sprinkled over with such spots is very short, sometimes a single day. The trouble is worse on open, dry land, but a diseased plant is not a source of danger to its neighbors.

That this disease is different from Mayer's mosaic disease is indicated by the fact that although, as Mayer had previously stated, a leaf in the last stages of "mosaic" might show a characteristic spotting, the "spotted disease" is never preceded by the mottled appearance associated with "mosaic." Neither insects nor fungi were found to be the cause of the "spotted disease," no bacteria were found in the affected spots, and infection of sound plants with the extract of diseased leaves

* Iwanowsky & Poloftzoff, Mém. de l'Acad. Imp. d. Sc. de St. Petersburg. XXXVII, No. 7. 1899.

failed to reproduce the disease. Hence it is concluded to be of a physiological character. Careful experiments by means of cultures in water and sand precluded the theory of a general or particular lack of the essential elements of plant-food as a cause of the spotting and, after numerous investigations, the conclusion was reached, and it appears to be incontrovertible, that a spotting of the lower leaves of a tobacco-plant may and does occur when the plant lacks water, owing to the drain of the upper and younger leaves upon the older, lower ones. A similar spotting of the middle leaves occurs whenever the plant, after having stood for some hours in a damp atmosphere, is suddenly transferred to a dry atmosphere, owing to the fact that, under such circumstances, the leaves transpire water faster than the roots can supply it. Such conditions are shown to exist in the field, and our authors conclude that cool, damp nights with abundant dew, followed by a sudden access of high temperature shortly after sunrise, accompanied by dry winds and rapid evaporation, are responsible for this peculiar spotting of tobacco leaves. "The 'spotted disease' of tobacco is a disease which first becomes apparent when a high degree of atmospheric humidity is succeeded by a period of rapid and excessive transpiration. A changeable climate, a few days of rain succeeded suddenly by hot sunshine, — rather than prolonged drought, causes the most severe spotting."

It is evident that in this so-called "spotted disease" of tobacco we have a disease very similar to, if not identical with, that known in Connecticut as "spotting," and, furthermore, that this disease is as distinct from the "mosaic" of foreign tobacco as "spotting" is from "calico." If the statements of the Russian investigators above mentioned are correct (and there is every reason for so regarding them), "spotting" is probably due to excessive transpiration induced by sudden atmospheric changes.

Returning now to the subject of "mosiac." In 1892 Iwanowsky* confirmed Mayer's statements that the sap of diseased leaves is contagious, that it loses its virulence upon being heated to nearly the boiling point, and that the disease is to be ascribed to bacterial infection. He denies, however, that the sap loses its virulence by filtration even through a

* Land-und Forstwirtschaft. 1892. Cf. Beih. z. Bot. Centralbl., Bd. III, p. 266.

Chamberland filter, and explains this fact on the ground that it contains a soluble poison excreted by the bacteria of "mosaic." Iwanowsky was unable to isolate the specific germ on artificial media, but he states that he saw the bacteria and proved their presence in the tissues of diseased leaves. Here he leaves the subject, giving no further information concerning the organism.

In 1894 the French investigators Prillieux and Delacroix* identified the "mosaic" disease with a similar disease of tobacco occurring in France, and known as "nielle" (smut). The latter is characterized by the formation of spots upon the leaf surface, where the tissue becomes dry and of a grayish-yellow color. These spots are surrounded by a dark colored line, where the cells are suberized (corky), and which limits the infected area. In the cells of the spots is found a motile bacillus, 0.66μ long, united in chains and imparting a yellow color to culture media. The article containing these notes is brief and very incomplete. The description given of the French disease raises serious doubts as to whether it is at all similar to the "mosaic" as described by Mayer.

In 1897 Marchal described,* under the name "La Mosaïque du Tabac" (the mosaic of tobacco), a disease which, in outward appearance, is fairly comparable to the one described by Mayer. He emphasizes, however, the spotting of the leaves, which, as has been shown, must probably be regarded as a different trouble, and merely repeats the observations of Prillieux and Delacroix that in the tissues of the grayish spots limited by a darker border is found a short, motile bacillus, forming chains in culture media, imparting to the latter a yellow color, and capable of reproducing the disease by inoculations from pure cultures. He states further that this natural contagion is inactive in the field and does not spread from a diseased to a healthy plant, but that in the soil of the seed-beds, replete with organic matter, it finds conditions highly favorable to its development. Here it attacks the seedlings, but inasmuch as its presence in the latter is indicated by no external symptom, it is impossible to distinguish and discard the diseased plants at the time of transplanting. The renewal or the sterilization of the soil in the seed-beds is therefore the only practical method of controlling the disease.

* C'mpt's rend. hebd. des Séances de l'Acad. des Sc., CXVIII-XII, p. 668. 1894.

† Revue Mycologique, XIX, 73, p. 13. 1897.

Finally, very recently, Beijerinck has ascribed the "mosaic" of tobacco to the action of a fluid not associated with bacteria, unlike any known enzyme, though acting in a similar manner, and possessing the ability to increase when brought into intimate association with the living protoplasm of active, formative tissues. I have been unable to obtain the original article in which this substance and its effects are described, but from the abstracts which I have seen* I gather that a good deal more work upon the subject is necessary before the conclusions of the author can be unqualifiedly accepted. This, so far as I know, completes the record of foreign investigations upon this class of tobacco diseases. It is evident that they consist of a number of isolated observations, made by investigators in widely separated localities and stated in terms which leave much to be inferred. What methods were used to isolate the specific germ and to avoid external contamination; what was the exact behavior of the germ in artificial cultures; what symptoms were produced in sound tobacco plants by inoculation either with pure cultures of the germ or with the extract of diseased tissues; whether these symptoms were identical with those observed by other investigators; whether from plants artificially infected the specific germ could again be isolated, and whether the diseases occurring in France are identical with those observed in eastern Europe and Asia,—all such questions are of primary importance, but concerning none of them have we any scientifically conclusive statements, with the possible exception of the work of the Russian investigators regarding the cause of the "spotted disease." One observer names and describes a disease which he infers is due to bacteria; a second states that he has seen the germ in the tissues, but has failed to isolate it; a third has isolated a germ from diseased leaves, but, according to his description, the external symptoms accompanying the presence of the germ differ materially from those described by the first observer and agree more nearly with those stated by a fourth to be characteristic of quite another disease due to entirely different causes. In view of these facts it seems best to limit our attention for the present to the diseases of tobacco which have come under our personal observation, and to record only such facts regarding them as our own experiments may in future elucidate.

*Centralbl. Bakt. u. Par., 2 Abth. Bd. V, No. 1, pp. 27-33, 1899.

MISCELLANEOUS NOTES ON PLANT-DISEASES
AND SPRAYING.

BY WM. C. STURGIS.

Monilia fructigena on the Peach. During the spring of 1898 many complaints were received to the effect that the blossoms and twigs of peach trees were rotting. The trouble was not confined to peaches, but was very common also on the ornamental shrub known as the Double-flowering Almond. Specimens received from various localities showed that the rotting was due to an exceptionally severe outbreak of the fungus, *Monilia fructigena*, which does so much damage to the stone fruits. It rarely happens that this fungus does serious injury except to the fruit and just before the latter ripens. But it will be remembered that the latter part of April and the whole of May were characterized by heavy rains and much damp weather, conditions peculiarly favorable to the growth of the fungus. Peach trees bloomed during the first week in May, and the blossoms, failing to set and being soaked by the continuous rains, fell an easy prey to the *Monilia*. After destroying the blossoms the fungus worked into the twigs, killing the tissues and causing the leaves to wither, turn brown and finally decay. From the infested tissues of the twigs and through cracks in the bark gum oozed in large drops, and after every rain the twigs, leaves and decaying flowers showed the ash-colored, dusty heaps of the fungous spores. During the fruiting season, also, the weather was exactly suited to the spread of this disease; during August the blighted twigs and leaves again became covered with the fungus which had been kept in abeyance by the dry weather of mid-summer, and it spread with great rapidity to the ripening fruit. Added to this, the wet weather of August induced a severe attack of the scab-fungus, *Cladosporium carpophilum*, so that it is doubtful if, in many years, the peach crop has been so disastrously affected by these two fungi.

As to remedial measures, some good would certainly have been done if, as soon as dry weather came, the blighted twigs had been cut off and burned. This was done in the case of a small double-flowering almond; the shrub recovered entirely and experienced no further damage from the fungus even dur-

ing the continuous wet weather of August. Judicious spraying, too, would have checked the rotting of the fruit, if we may judge by the excellent results attending the use of Bordeaux mixture in other places, notably in Delaware.* Our own experience, however, has been such as to cause us to hesitate before recommending the treatment of peach trees with Bordeaux mixture. Last year, in accordance with our advice, Mr. J. H. Hale of South Glastonbury sprayed a portion of his peach orchard, with the result that all of the sprayed trees lost their leaves. They recovered later and bore almost a full crop of fruit, but the loss of the leaves weakened the trees, and was undoubtedly caused by the Bordeaux mixture. During the past summer all of the fruit trees on the Station grounds, including a few peaches, Japanese plums, and apricots, were thoroughly sprayed with Bordeaux mixture made on the 6-4-50 formula. The foliage of quinces, pears, European plums, and apples was uninjured, but the peaches, Japanese plums, and apricots were completely defoliated, and the individual leaves presented the exact appearance of leaves affected with the shot-hole fungus. No fungus was found upon them and the injury was attributed entirely, and I believe rightly, to the Bordeaux mixture. I am unable to account for the discrepancy between this result and that uniformly obtained in Delaware, unless it be that our mixture was too strong. In Delaware six pounds of copper sulphate and nine pounds of lime are used in making fifty gallons of the mixture. We used the same proportion of copper sulphate but only four pounds of lime, on the supposition that sufficient lime to neutralize the whole of the copper sulphate would ensure the foliage against injury. This does not seem to be the case, and further experiments are needed to show just what form of Bordeaux mixture can be safely used upon peach trees.†

A Bacterial Blight of Lima Beans. Early in August the lima beans on the farm of Mr. S. B. Smith of East Haven began to show a peculiar blighted appearance. On the leaves were numerous reddish spots, circular in outline and bounded by a darker-colored border. Sometimes two or more of these spots coalesce. On the pods the first sign of the trouble is a small depressed spot, still green like the rest of the pod, but appear-

* See Del. Coll. Agr. Exp. Sta., Rep. IX, 1897, pp. 20-30.

† Cf. Corn. Univ. Agr. Exp. Sta., Bull. 164, pp. 385-388, 1896.

ing watery and translucent; later the tissues of such spots become discolored and the spots themselves finally resemble those on the leaves. Thin sections through such a spot show that the cells are filled with a motile bacillus apparently identical with *Bacillus Phaseoli*, Sm.* This bacterial blight was first noted on lima beans by Professor S. A. Beach of the New York Experiment Station.† In 1893 Professor B. D. Halsted described a similar disease on wax beans,* and it seems fairly certain that both diseases are caused by the same organism. On wax beans the disease has been known certainly since 1886, but its occurrence on lima beans seems to be more recent. That it bids fair to become a very serious trouble was evident from its effects upon the beans at Mr. Smith's. Within a week after its first appearance it had swept over the whole field, the vines looked as though they had been sprayed with some caustic liquid, and, although no exact determination was made, probably ten per cent. of the pods were rendered unmarketable, to say nothing of the weakening of the vines by the partial destruction of the foliage.

Halsted has shown‡ that seed from blighted pods may reproduce the disease; that the latter is worse upon land which has previously borne a diseased crop, especially if any of the refuse remains on the land; that an excess of moisture is favorable to the spread of the disease, and that it may be checked in a measure by the use of Bordeaux mixture. Where this disease is prevalent, therefore, great care should be taken to secure seed from a locality known to be free from it; if the crop has been diseased, neither wax nor lima beans should be grown on that same soil the next year; well-drained land should be selected, and, if practicable, the vines should be thoroughly sprayed with Bordeaux mixture. Two sprayings between July 15th and August 15th would probably serve to lessen very decidedly the injury caused by both the bacterial blight and the mildew.

The Damping-off of Peas. The damping-off of seedlings is a trouble only too well known to every one who has had much to do with growing plants under glass. It is characterized by

* Proc. Am. Asso. Adv. Sc., XLVI, p. 288. 1898.

† N. Y. Agr. Exp. Sta., Bull. 48, p. 331. 1892.

‡ N. J. Agr. Exp. Sta., Rep. 13 (1892), p. 283. 1893.

§ N. J. Agr. Exp. Sta., Rep. 17 (1896), pp. 328-333. 1897.

a sudden wilting of the seedlings, due evidently to a decay of the stem at the surface of the soil. If the stem is examined in the early stages of the disease, the tissues will be found to be traversed in all directions by the colorless vegetative threads (*hyphae*) of a fungus. These threads produce various kinds of reproductive bodies which either have their rise in a sexual process (*oospores*) or are produced non-sexually (*conidia* and *zoospores*). The fungus has long been known and bears the name *Artotrogus De Baryanus* (Hesse).^{*} It does not often cause serious damage in the open, since for its best development it requires a high temperature, considerable moisture, and a close atmosphere, but it greatly injured garden peas during the past summer, the young plants decaying to such an extent that in one locality, at least, it was a difficult matter to get a crop. Microscopic examination of the infested seedlings showed an abundance of *oospores* in the tissues of the stems. These agreed perfectly with those of *Artotrogus De Baryanus*, but, according to Hesse, this species does not attack peas. Atkinson mentions in the Cornell Bulletin above referred to, p. 252, a species, — *Artotrogus Sadebeckianus* (Wittmack), "producing epidemics of diseases in lupines and peas," but I have been unable to find any description of this species or to determine whether the one noted on peas is identical with this or not. In any case, the course to be followed in order to prevent a recurrence of the trouble would be the same, viz.: thin planting, to secure an abundance of light and air for the seedlings; the avoidance of a heavy soil containing an excess of water; and the use of chemical fertilizers where practicable, rather than barnyard manure, upon the organic matter of which the fungus can feed and grow.

Plant-Diseases and the Weather. There is a general impression that wet weather is in itself a cause of the fungous diseases of plants. This is based upon the fact that during a period of damp weather plants are prone to suffer from a variety of diseases known as mildews, blights, rusts, molds, etc., which are not apparent in dry weather. But, in so far as such diseases are connected with parasitic fungi, it is no more true that they are caused by wet weather than that the occurrence of weeds is due to that cause. A certain weed can only have

^{*} For a full description of this and other "damping-off" fungi, see Cornell Univ. Agr. Exp. Sta., Bull. 94. 1895.

its origin in a seed of that same species, although the plant developed from that seed may require damp weather for its growth. In the same way and for the same reason a fungus has its origin in a spore which requires moisture for its germination and development. If there were no weed-seeds there would be no weeds; if there were no spores, speaking broadly, there would be no fungi or fungous diseases, no matter whether the weather were wet or dry. The past season has exemplified the connection which exists between wet weather and the spread of plant-diseases due to fungi, but in one case at least it has shown how dry weather may induce disease. About the middle of July it was noticed that wax beans were seriously diseased. The leaves were covered with large yellow blotches which in turn bore a copious growth of a black mold. The appearance of such leaves was very striking and it was thought at first that they were suffering from the attacks of one of the black "rusts." Further investigation, however, showed that the black mold was a species of *Alternaria*, which occurs commonly on dead leaf-tissues. For some time search was vainly made for the cause of the yellowing of the leaves, but finally a patch of beans was found on which the trouble had developed more recently. It was then seen that the leaves were infested beneath with the mite commonly known as "red spider," and that the yellow blotches corresponded to the areas where the mites were present in the largest numbers. Growers of plants under glass are familiar with the fact that the foliage of many plants, if kept dry, is subject to the attacks of "red spider," and that two or three syringings with clear water is sufficient to remedy the trouble. In a certain sense, then, this trouble is dependent upon the atmospheric conditions. The past season presented exceptionally favorable conditions for the "red spider." The month of June was extremely dry and the insects multiplied very rapidly on the lower surface of the bean-leaves; three heavy rains occurred on July 4th, 12th, and 13th, which sufficed to destroy the mites, but not before the latter had caused the yellowing of the leaves and the death of the tissues in large patches; the warm, damp weather which followed gave an opportunity for the development of fungi, and on the dead patches there soon appeared the black mold. It was a striking illustration of the effects of both dry and wet weather, not in directly causing a diseased condition, but in giving a

favorable opportunity for the development of parasitic organisms. Doubtless if the beans could have been thoroughly syringed with water two or three times in June, they would have remained healthy notwithstanding the dry weather.

A Convenient Method of Preparing Bordeaux Mixture in Small Quantities. In experimental work where small plots have to be sprayed, I proceed as follows, using the 5-5-50 formula as being at the same time efficient, safe, and readily divisible by 5 or 10. Half a pound of copper sulphate is dissolved in a quart of hot water and poured into a fruit-jar of that capacity; half a pound of lime is slacked, diluted with water to make a quart, and placed in another fruit-jar. These amounts are easily weighed out, the operation of dissolving and slacking can be done quickly, and in a couple of hours enough half-pound lots of sulphate and of lime can be prepared to make a good many gallons of Bordeaux mixture, and, if the jars are tightly closed, their contents will keep indefinitely. To make five gallons of Bordeaux mixture an ordinary wooden pail holding two gallons and a half, and a forty-pound (five-gallon) candy pail such as can be cheaply bought of any grocer, are needed. Into the latter is poured the contents of one jar of lime and the pail is then half filled with water. Into the small pail is emptied a jar of copper sulphate solution and this pail is then filled with water. Finally, by pouring the contents of the small pail quickly into the large pail and stirring well, a perfect Bordeaux mixture is obtained. If a weaker mixture is desired, the five gallons of full strength may be made up, half of it poured back into the smaller pail and then the larger pail filled up with water. Both solutions being dilute and being mixed quickly by a single operation, the hydroxide of copper is precipitated in a very finely divided form and does not settle readily or clog the nozzle.

Notes on Spraying Apparatus. During the past season we have experimented with a number of pumps adapted for use with a barrel or with a pail. Among the barrel-pumps, two have done admirable work. These are the "Eclipse, No. 2," manufactured by Messrs. Morrill & Morley of Benton Harbor, Mich., and the "Pomona," made by the Gould's Manufacturing Company of Seneca Falls, N. Y. The principle upon which these two pumps work is practically the same and was described in our Bulletin 125. The "Eclipse" works a little

more easily than the "Pomona," it is a trifle lighter, and the mechanism is simpler. On the other hand the "Pomona" is made in two forms adapted either to the head or the side of the barrel, while the "Eclipse" can only be used on the head. These pumps represent the most efficient type of spraying-pump on the market and both are thoroughly satisfactory.

The bamboo-extension made by Morrill & Morley is the best appliance we have yet seen for directing a spray into the tops of trees. It is simply a light bamboo pole, bored out and lined with brass. When fitted with a double Vermorel nozzle it delivers a far-reaching spray, covering a large area.

Of all the pail-pumps which we have used, the "Success Kerosene Sprayer," manufactured by the Deming Company of Salem, Ohio, has proved the most serviceable. This pump has a detachable tank for kerosene, from which the oil is drawn by the stroke of the piston, is mixed in the cylinder with the water contained in the pail, and issues from the nozzle in the form of an emulsion. A gauge regulates the supply of kerosene from zero up to 50 per cent., and tests which we have made indicate that the gauge is fairly accurate. We have used this apparatus, with the gauge set to deliver 20 per cent. of kerosene, to destroy plant-lice on Viburnum, roses, honeysuckles, and other plants. The leaves were uninjured, while the lice were completely destroyed.

With the tank removed and the aperture closed by a screw-cap, this pump can be used with fungicides. It is well adapted for the spraying of plants on a small scale and was used with great satisfaction in some of our spraying work during the past season.

ROSE CULTURES.

BY W. E. BRITTON.

In October, 1897, a small section of bench space in the forcing house having an area of 14.5 square feet was equally divided by a partition and one-half filled with compost, the other with a mixture of coal ashes and peat moss. To the latter were added 15 grams of nitrogen in nitrate of soda, 6 grams of phosphoric acid in dissolved bone black, and 30 grams of potash in muriate. For 100 square feet of bench space these applications would be 2 lbs. 12 oz. of nitrate, 1 lb. 1 oz. of dissolved bone black, and 1 lb. 15 oz. of muriate. Fifty grams of carbonate of lime were added to each plot. In the center of each plot was set a Duchesse de Brabant rose which had been growing for two years, and in the corners four other plants of the same variety of a year's growth.

The plants in the coal ashes at first dropped their leaves more than those in the compost, but soon put out new ones and began to bloom. The plants in both plots blossomed continually all winter and were exceedingly thrifty with perfect foliage, free from mildew. The plants set in coal ashes and peat gave larger blooms, but rather lighter in color than those from the compost plot. There was no difference as regards fragrance and form. The first blossom was picked December 4th, and the last one June 2d, when the plants were removed from the benches. The fertilizers added as well as the yields obtained is given in the following table:

ROSE CULTURES.

SOIL.	PLOT 207 A.	PLOT 207 B.
	Compost.	Coal Ashes and Peat Moss.
<i>Fertilizers (grams) —</i>		
Nitrate of soda,	0	94.8
Equivalent nitrogen, . . . . .	..	15.
Dissolved boneblack,	0	35.34
Equivalent phosphoric acid, . . . . .	..	6.
Muriate of potash,	0	64.5
Equivalent potash, . . . . .	..	30.
<i>Yield —</i>		
Total number of blooms,	42	58
Average diameter of blooms, inches,	2.20	2.28
Average length of stem, inches,	4	4.8
Average weight of blooms, grams,	5	6

ENTOMOLOGICAL NOTES.

BY W. E. BRITTON.

Ravages of the Squash Lady-Beetle. — The squash lady-bird, *Epilachna borealis*, Fabr, injured squash vines at the Station by devouring the foliage during August and September. Most of the lady-beetles (*Coccinellidæ*) are beneficial instead of injurious, and feed upon other insects such as plant-lice, scales, and larvæ. There are two or three species, however, that injure cultivated plants, and *E. borealis* is the one most commonly found in the Northern and Eastern States. The insect feeds in both the larval and adult stages. The adult has a curious habit of marking out a circular area upon the leaf and then feeding within this area until all the soft tissue has been devoured, when another feeding ground is marked out and in turn exhausted. The eggs are deposited in clusters on the leaves and hatch in about twelve days, according to Professor J. B. Smith,* who has given the species considerable study. Smith states that he observed a newly-hatched larva devour several unhatched eggs of the cluster, showing that the carnivorous habits of the family have not been overcome entirely in this herbivorous species. Most of the feeding is done, however, in the larval state. The larva is light yellow in color and covered with black forked spines. Pupæ are also found upon the leaves. The adult beetle is yellowish-brown in color with seven black spots upon each wing-cover and four smaller ones upon the thorax. It is about three-eighths of an inch in length. This is the first time in five years that the species has been injurious in the Station garden. An application of arsenical poison when the beetles first commence to feed will prevent any serious injury.

Genista Injured by Blister Beetles. — Several species of "blister beetles" feed upon a great variety of plants. About the middle of June some plants of *Genista tinctoria* in an ornamental planting were considerably injured by a gray blister beetle, *Macrobasis unicolor*, Kirby. Hand-picking was practiced in this case, but an application of paris green or any of the other arsenites would probably prevent any great injury.

Leaf-Beetle on the Hornbeam. — On May 30th, adults of *Serica trocifformis*, Burm., were abundant on young trees of the

* New Jersey Experiment Station, bulletin 94.

hornbeam or water beech, *Carpinus Caroliniana*, in Westville. The foliage was completely riddled in some cases. Both sexes were present. The female is of a reddish brown color with black head and thorax. The male is of a uniform color and nearly black. This beetle is about one-fourth of an inch in length and both male and female are about the same size. Poisoning of the foliage will, of course, prevent it from being seriously injured by this beetle.

Elm Leaf Beetle. — The elm leaf beetle, *Galerucella luteola*, Mull., which for the last few years has seriously injured elm trees in Connecticut, was much less abundant during 1898 than for several seasons previous. It could be found, however, without much hunting, and many small trees in New Haven were defoliated. On most of the larger trees the injury was scarcely noticeable; in one or two localities the trees presented a brown color, caused by the larvæ of this beetle devouring the green portion of the foliage. We are probably not yet rid of the pest, and tree owners and municipal authorities should be on the watch for its appearance the coming season, fully prepared to save the trees if the beetle appears to be present in threatening numbers.

A Borer in Plum Trees. — During June Mr. M. N. Woodling of Hamden sent to the Station a section of the trunk of a Japan plum tree which was infested with borers. The piece of wood was placed in the breeding cage until we had time to examine it. Meantime, the borers did not seem inclined to emerge from their burrows or tunnels, the openings of which were plainly discernible scattered over the bark. Upon splitting open the tree-trunk many small dark-colored beetles were found in the burrows. The larval and pupal stages were also represented. The species is closely allied to, but entirely distinct from, the destructive "fruit bark beetle" that has become so well known in Connecticut orchards. The former burrows wholly inside the wood, while the latter works between the wood and the bark. By the courtesy of Dr. L. O. Howard, entomologist of the Department of Agriculture, Washington, D. C., one of his assistants identified the species as *Xyleborus pyri*, Peck. It is now considered identical with the European *X. dispar*, Fabr. Miss Ormerod states* that this insect was rare in England until ten years ago, when it seriously damaged

* A Text-Book of Agricultural Entomology, p. 101.

young plum trees in two or three localities. In this country the beetle occasionally injures the tulip tree (*Liriodendron*) and various kinds of fruit trees. Both sexes were found in the tunnels.

The female is about one-eighth of an inch in length and one-sixteenth in breadth. The male is considerable smaller, being three-thirty-seconds of an inch long and having about the same breadth of body as the female. The male, however, is much thinner and the extremities of the body taper much less abruptly. Both sexes are black or dark brown in color.

The tunnels were cylindrical in shape and extended to the center of the trunk, which was about three inches in diameter. Ramifications were not numerous, but were found in several clefts. A fungus was growing inside the tunnels, and is said to be "cultivated" by several species of beetles whose larvæ as well as adults feed upon it inside the burrows. *Xyleborus dispar* is often called the "pear blight beetle," but it has no connection with either the fungous or the bacterial disease of the pear sometimes called "pear blight."

It is doubtful if a satisfactory remedy can be suggested against the injury done by *Xyleborus dispar*, which is likely to be only occasional. Perhaps if the trunks and branches of trees are coated with whitewash or Bordeaux mixture to which a little Paris green has been added, an attack may be prevented.

The Oak Pruner. — During the latter part of summer, the ground underneath many of the oak trees in and about New Haven was thickly strewn with twigs which had fallen from them as if broken off by the wind. Examination of these twigs showed that each one had been eaten nearly off, and that it contained a burrow usually at the pith. If the twig were split open along the line of the burrow, a borer about three-eighths of an inch long would be found inside. This is the half-grown larva of a small brown beetle, *Elaphidion villosum*, Fabr.

The beetle deposits the egg near the tip of a young branch and when hatched the borer works his way inside the twig and burrows along the pith. When nearly half-grown he cuts the twig nearly off and retreats into his burrow. These twigs, almost severed by the larvæ, are easily broken off by winds and fall to the ground. The borer remains in his burrow in the fallen twig until the following spring, sometimes in the larval

and sometimes in the pupal state. The adult appears about midsummer.

The only remedial treatment that can be recommended against this curious insect is to gather and burn all infested twigs, thus destroying the larvæ in the burrows, and somewhat lessening the number the following year.

Kerosene and the San José Scale. — Since preparing the last Annual Report, the San José scale has been reported from Ivoryton, Nichols, Cheshire, Burnside, and Rowayton. In addition to these new places, new centers of infection have been discovered in New Haven, Hartford, and Bridgeport.

There are indications that the scale spreads somewhat less rapidly in Connecticut than many believed it would, but it still remains a dreaded pest of the fruit grower, and orchardists and nurserymen need to be always on the watch lest the insect be introduced into their domains.

Spraying with clear kerosene has been given a trial in Connecticut. On the 1st of last March several seriously infested Japan plum trees in New Haven were sprayed with kerosene. Two months later no living scales could be found. The kerosene was purchased in the market for illuminating purposes and was supposed to be of good quality. It was applied by means of a "Success" bucket pump, through a Vermorel nozzle, and the spraying was done on a bright day with plenty of air stirring, so that evaporation would be rapid. Where the kerosene was applied with care, little or no injury resulted. One tree literally covered with scales from top to bottom was drenched with kerosene; nearly all the branches were killed back about half way to the trunk.

At the Station, uninfested trees of apple, pear, peach, plum, cherry, and quince were sprayed with kerosene on February 28th. For several weeks no injury was apparent. Later, it was observed that some of the fruit buds and small twigs had been killed.

Spraying with clear kerosene is scarcely a safe treatment for the average grower to employ. If his trees are infested he had better apply kerosene and water, which will do less injury and will kill the scale. At the Cornell Station, excellent results were obtained by using a mixture containing 20 per cent. of kerosene. For this work a special pump is necessary. A suitable outfit has been figured in Bulletin 126, p. 7, of this Station.

A similar pump is now manufactured by the Goulds Manufacturing Company of Seneca Falls, N. Y.

Elm Scale. — On June 14th my attention was called to a young elm tree near the Station that was infested with scales. I found the insect to be the elm scale, *Gossyparia ulmi*, Geoff. It was easily killed by washing the tree with a strong solution of ordinary soap. Whale-oil soap would probably be better.

Other Scale Insects. — Various species of scale insects have been received during the season from different sections of the State. Among the most common are the "Oyster Shell Bark-Louse," *Mytilaspis pomorum*, Bouché, and the "Scurfy Bark-Louse," *Chionaspis furfurus*, Fitch. The former is especially common upon apple, lilac, birch, ash, willow, and poplar, and is a long and slender curved scale, nearly the same color as the bark upon which it is fastened. The latter species is light gray in color, is broad and pear-shaped and commonly infests the apple and pear. Both of these insects winter as eggs, which are not easily killed by insecticides, but if the infested trees are treated with whale-oil soap solution just after the eggs hatch, or about June 1st, the young insects are very easily destroyed.

The Rose scale, *Diaspis rosæ*, Sand., is also received here frequently. This is a large scale, the adult females being one-eighth of an inch in diameter, nearly circular in outline, very light gray in color, and found upon the rose, blackberry, raspberry, and sometimes the pear. The "tulip scale," *Lecanium tulipifera*, Cook, is also common. It is a large brown scale nearly hemispherical in shape and infests the small branches of the tulip tree.

A *Lecanium* on the grape was received in June from Bristol; it has not yet been determined, and perhaps is a new species. The several species comprising the genus *Lecanium* have no armor and are called soft scales. They are very susceptible to contact insecticides such as whale-oil soap solution, and the rose scale can be controlled in the same manner.

Woolly Aphis on Pine. — About the middle of June plant lice were noticed on several small pine trees (*Pinus strobus*) growing at the Station. Their bodies were covered with a whitish cottony substance, and they resembled the well-known woolly aphis of the apple, and answered the description of a closely allied species, *Schizoneura pinicola*, Thomas. A single

spraying with fir tree oil rid the trees of their woolly parasites.

The Pear Psylla. — *Psylla pyricola*, Först., was unusually abundant throughout Connecticut in 1898. It was first noticed at the Station about July 1st and had then somewhat injured the pear trees.

The pear psylla is a jumping plant louse of about one-tenth of an inch in length. It injures the trees by sucking the sap from the tender twigs. It exudes a sweet sticky "honey-dew," which soon covers the foliage and branches. In the honey-dew a fungus grows, giving the trees a blackened sooty appearance. The leaves usually turn yellow or red and fall prematurely.

This insect is rather hard to control and an insecticide which kills by contact should be used against it. The most vulnerable period in its life history is just after the leaves of the pear tree expand in the spring. Honey-dew is not then abundant, and a thorough application of kerosene emulsion or whale-oil soap will destroy many of the insects. If it becomes necessary to give a later treatment, the application should be made after a rain, as some of the honey-dew is then washed off and the insecticide will be more likely to come in contact with the insects.

Peas Injured by the Zebra Caterpillar. — On June 14th, pea vines in the Station garden were fast being devoured by small caterpillars. Several plants had already been stripped of their leaves. The young larvæ placed in the breeding-cage and properly fed grew rapidly, and after one or two moultings were easily recognized as the larvæ of the zebra moth, *Mamestra picta*, Harr. This identification was confirmed later by the emergence of the adults.

Many garden plants are subject to an occasional attack from this species, but it is rather seldom that much injury is caused. The arsenites will keep it in check if properly applied.

Red Humped Caterpillar. — This caterpillar was abundant on some black walnut (*Juglans nigra*) seedlings at the Station during September. The larvæ were rapidly devouring the foliage when found and further injury was prevented by gathering the caterpillars. Spraying with the arsenites is the usual remedy. The insect is known as *Ædemasia concinna*, S. & A., and frequently feeds upon the foliage of the apple tree.

Chrysanthemum Stalk Borer. — On June 29th, some chrysan-

themum stems were sent to the Station from Newington. The plants had been injured by some insect that burrowed in the pith. In one of the stalks was a larva of the moth, *Gortyna nitela*, Gueneé, and this species was probably the author of the injury. Cornstalks containing larvæ of the same species were also received during the season. There is no remedy except to destroy the insects when found.

Angoumois Grain Moth. — October 11th some ears of popcorn were sent to the Station from a large storehouse. The grain was thoroughly infested with the Angoumois Grain Moth, *Sitotroga cerealella*, Oliv., which is abundant in granaries and storehouses throughout the eastern United States, and which attacks growing corn in the South.

The best remedy is to enclose the grain in tight boxes or bins and treat with carbon bisulphide, using one pound of the liquid for each one hundred bushels of grain.

EXPERIMENTS IN CHESTNUT GRAFTING.

BY W. E. BRITTON.

Purpose of Experiments. — Since the coming of the Japanese chestnuts a new interest in chestnut culture has been awakened in Connecticut. The native chestnut *Castanea dentata*, (Marsh.) Borkh. grows naturally throughout the State and covers a considerable portion of the wooded area. Trees have been cut over many acres and some of the sprouts issuing from the stumps are of a suitable size to graft. It has long been known that the chestnut could be grafted, and since the improved varieties of European and Japanese chestnuts were obtained there have been many attempts to graft these upon the native stocks. The practice, however, has not been wholly successful, and the work described in this paper was carried out in order to determine the most favorable time for setting cions in this latitude, and also the best methods of grafting.

Stocks. — The stocks used were all of the American species; the cions were set either in the more thrifty branches of large trees, in young seedlings, or in sprouts which had sprung up from the stumps of a previous growth of chestnut timber.

Cions of the following varieties, representing two botanical species, were used in the experiment, viz.: European Chestnut, *Castanea Castanea* (L.) Sudworth: varieties, Paragon, Ridgely, Comfort, and Numbo; Japanese Chestnut, *Castanea Japonica*, Blume: varieties, Alpha, Reliance, Superb.

A portion of the cions were bought from the Pomona Nurseries, Parry, N. J., and others were kindly given by Mr. J. H. Hale of South Glastonbury and Mr. N. S. Platt of New Haven. All the cions were dormant when set. After being cut from the trees they were kept in a dormant condition by storing them in damp sand in a dark portion of the ice-house.

Characteristics of the Cions. — It will be interesting and profitable to note briefly the difference in twigs or cions between the American, European, and Japanese species. Though this is a botanical consideration it is of practical value, and has been mentioned much less frequently in chestnut literature than the characters of the foliage and fruit, which will not be touched upon in this paper. A person familiar with the three kinds of chestnuts can usually distinguish them by the appearance of the matured twigs or cions. The three species

are represented by their twigs in Plate 1. Each has alternate buds borne upon opposite sides of the shoot.

American Chestnut twigs are rather slender, nearly cylindrical though often irregular, and considerably enlarged below the buds. The buds are prominent, but smaller and closer together than the European. Twigs often branch on young and vigorous trees and such wood is more apt to have an irregular and fluted surface than the cions taken from large trees. The twigs seem to be somewhat lighter and duller in color than those of the other species, though the color probably varies greatly in the several varieties.

European Chestnut twigs are long-jointed with an angular or irregularly fluted or corrugated surface and much thickened just below and in the direction of the buds. Cions of Paragon and Ridgely are extremely irregular, while those of Numbo and Comfort are more nearly circular in cross-section. The species is a strong grower, the cions often making a growth of five or six feet the first season. (Plate 2.) The wood is therefore large and coarse, tapering slowly toward the tip, with the buds large and far apart. Fewer cions to the foot can be cut from this wood than from either the American or Japanese species. The wood is also much harder to work in grafting on account of the irregularity of surface. A vigorous shoot often branches or produces laterals the same season.

The lenticels or white spots on the bark of the four varieties here noticed are far more abundant than on twigs of the American or Japanese chestnuts. This is especially true of the Paragon. The leaf-scars below the buds are also larger and of different shape.

Japanese Chestnuts produce cions which are very unlike the European. The wood is nearly cylindrical, though slightly flattened, the greatest diameter being between the sides which bear the buds. The buds are small, almost triangular with acute points, and are much nearer together on the stem than in either the American or European chestnuts. The twigs are smooth and of good size at the base, but there is a greater tendency for the young growth to branch (*i. e.*, produce laterals) than in the other species; so that it is common to find forked cions, and above the fork the wood is small and slender, tapering to a size that is altogether too small to use for cions except in very small stocks. These slender tips should be discarded.

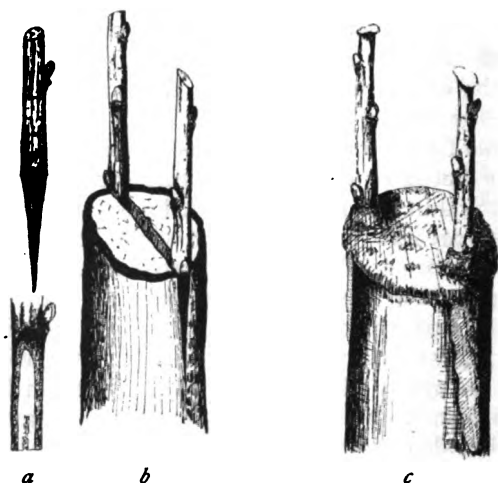


FIG. 1. — Cleft-grafting; *a* shows how the cions should be cut; *b*, cions set in stock; *c*, the same waxed.

Forms of Grafts Employed. — 1. The *common cleft-graft* (see Fig. 1.) was chiefly used. Two cions were usually placed in each stock; in a few small stocks single cions were set. Where cleft-grafting is practiced the best results will be obtained in selecting stocks between one-half and one and one-half inches in diameter. Except in very small stocks this form of graft needs no tying; the pressure of the stock holds the cion in place.

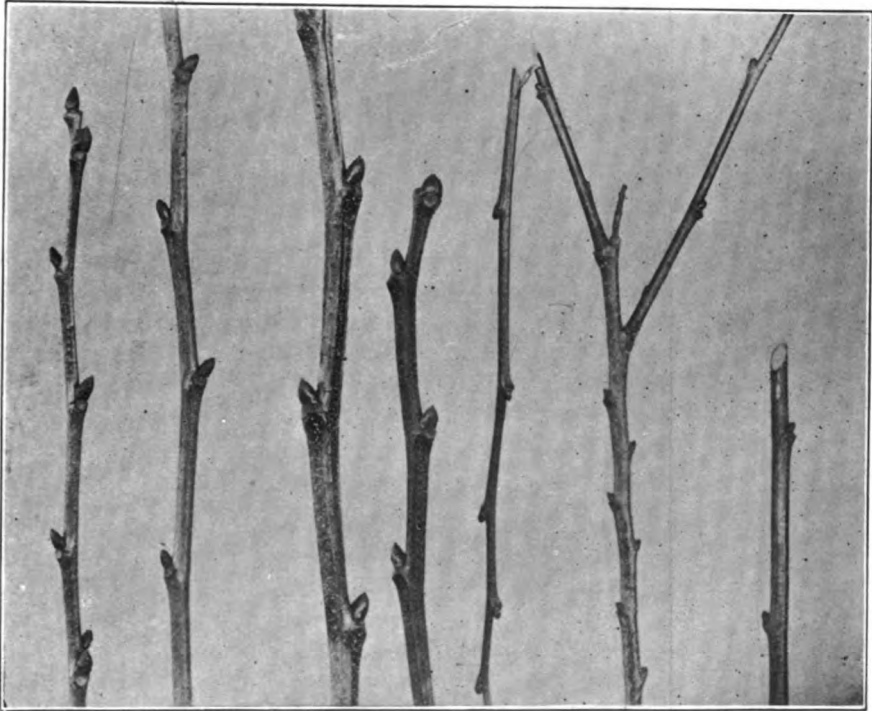
*a**b**c*

PLATE I.—CHESTNUT TWIGS.

a American chestnut; *C. dentata* (Marsh) Borkh.*b* European chestnut; *C. castanea* (L.) Sudworth.*c* Japanese chestnut; *C. japonica* Blume.

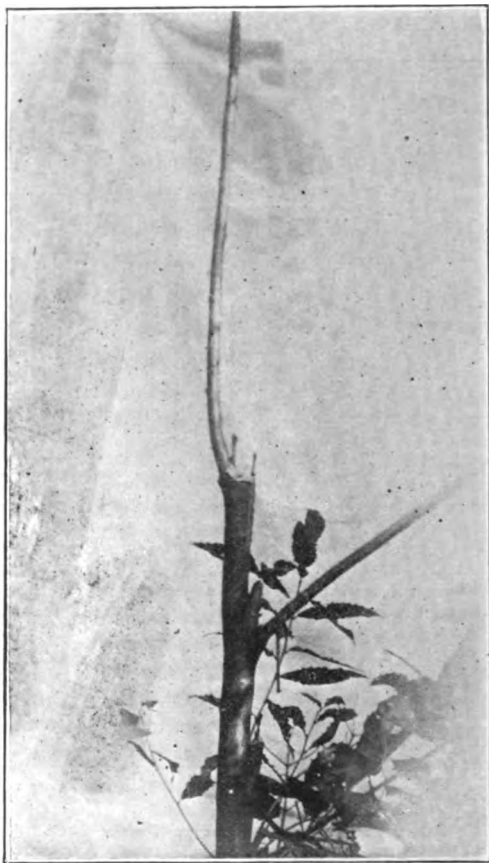


PLATE 2.— Chestnut cleft-graft; Ridgely cions, set May 6th; grew over six feet the first season.

2. The *tongue or whip graft* was employed where it seemed desirable to graft small twigs nearly as small as the cion itself. A better union of cion and stock followed this form of graft. The tongue graft and the method of preparing the cion are shown in Fig. 2. This graft should always be tied.

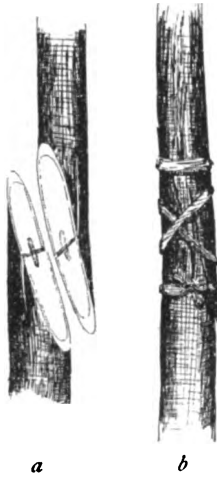


FIG. 2. — Tongue or whip graft; *a* shows manner of preparing stock and cion; *b*, the same, put together and tied.

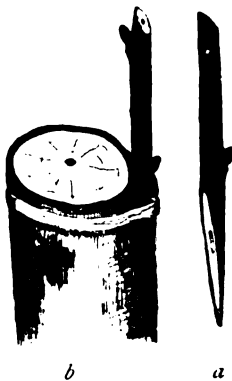


FIG. 3. — Bark graft; *a* shows method of cutting cion; *b* cion has been inserted and tied, but not waxed.

The third form of graft may be called a *bark graft*.^{*} The cion is cut wholly on one side to the form of a wedge. During the grafting season the bark of the chestnut separates easily from the wood and usually the cion can be readily pushed into its place after inserting the point between the bark and wood of the stock. A knife is sometimes necessary to make an opening. The bark of the stock usually splits open along the outside of the cion; but the bark alone of the cion is exposed so that the split does no harm. It is safer to tie this form of graft (which is shown in Fig. 3), though in several cases a union and good growth were made where not tied.

Preparing and Setting the Cions. — It is a common practice with grafters to cut the cions into sections, each portion having two buds, or more if the buds are close together, as in case of the Japanese chestnut. The lower end of the cion is then cut in the shape of a wedge on one or two sides, according to the form of graft to be made. Clean cuts should be made, and for this purpose it is imperative that a very sharp knife be used. The cut should be smooth and even, and is better if made with a single sweep of the knife. After sawing off the stock at a convenient size, it is advisable to pare the outer edge of the cut surface of the stock with a sharp knife. This probably allows a more perfect contact with the wax and favors the healing of the wound, but the principal reason for doing it is to remove the torn wood so that the grafter can see to get the cion in the proper place. The stock is then split and a wedge is driven into the cleft to open it. The cions are then set in the cleft with the cambium (or inner bark) of the cion directly in contact with the cambium of the stock. Great care should be taken in setting the cions. The knife for splitting and the wedge for opening the stock are usually combined in one tool, different forms of which are shown in Fig. 4, and which may be procured from almost any seedsman or nurseryman. A good pocket knife is the only tool needed in making a tongue graft, and a grafting tool is used only in a cleft-graft.

Waxing the Grafts. — Whichever form of graft is employed, the cut and cleft surfaces of stock and cion should always be protected by covering with wax. This keeps the graft from

^{*} Some writers call this a *crown graft*, but a *crown graft* may be any sort of a graft at the crown of the tree or plant, i. e., at the surface of the ground. To avoid confusion, therefore, I prefer to call the graft herein described a *bark graft*.

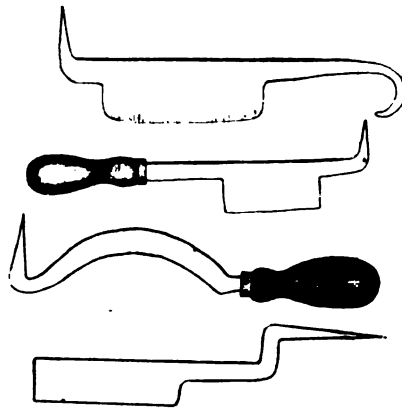


FIG. 4. — Various forms of grafting tools.

drying out and at the same time prevents the germs of decay from coming in contact with the mutilated surfaces of the wood. In the experiments herein described wax was used liberally and great care exercised that it be made to adhere firmly to the stock and cions, leaving no possible chances for air to enter or water to escape. The tops of the cions where cut were also well covered with wax.

Grafting Wax.— There are various formulas for making grafting wax, and doubtless most of them give good results. The wax used in this experiment was made after the following formula, which the writer prefers to some others :

Common Rosin	. . . . .	4 pounds.
Tallow,	. . . . .	1 pound.
Beeswax,	. . . . .	1 "
Gum Shellac,	. . . . .	$\frac{1}{2}$ ounce.

The tallow should be melted first in a kettle over a fire ; the rosin should then be added, and when nearly melted add the beeswax. After all is in liquid form add the shellac and stir constantly to prevent the last-named substance from collecting in lumps or from burning on the bottom of the kettle. Pour the contents of the kettle when well melted into a greased basin filled with water. After a few minutes separate the wax into lumps of from one-quarter to one-half pound each, and "pull" vigorously until uniform in color and texture. It is then ready for use. If not well "pulled" or "worked," it will be of a dark color and lumpy.

Tying Material. — Raffia is the best and cheapest tying material and was used in this work. It should be moistened before using. Many grafters prefer to combine their tying material with the wax by using strips of cotton cloth that have been dipped in the melted wax. These strips are wound about the graft, which requires no extra tying or waxing. Cotton twine, yarn, or any pliable fiber may be used for tying, but the flat bark fibers are better, as there is less danger of cutting or girdling the graft. Any material should be cut when the graft begins to enlarge.

Time and Place of Grafting. More than 200 cions were set in five localities in or near New Haven. The first grafting was done April 20th, but the cions made no growth for a month. The stocks were then well advanced in growth. Of the cions set, four were knocked out of place, two pulled out by boys, and four made good growth, but were broken off, presumably by winds. Twelve started to grow and then died; ten of these were set in thrifty sprouts growing upon the top of a dry gravelly knoll and were killed by drought. The cions which started to grow and afterwards failed are excluded from the percentages given in the table below.

TABLE I. — RESULTS OF CHESTNUT GRAFTING, 1898.

Time of setting cions.	No. of cions set.	ALIVE OCTOBER 1ST.		
		No. of cions alive.	Per cent. of No. set.	Average growth.
Between April 20th and May 1st,	29	3	10	18 inches
" May 1st and May 15th, .	56	26	46	28 "
" May 15th and June 1st,	41	13	32	23 "
" June 1st and June 15th,	47	22	47	22 "
After June 15th,	12	2	17	8 "

From the table it appears that a greater percentage of cions failed among those set previous to May 1st and after June 15th than among those set between these dates. Of cions set during the first half of May and those set during the first half of June the percentages that grew are practically the same. Of cions set the latter half of May a somewhat smaller percentage survived, probably because they were set in the tops of large

trees, while the others were mostly placed in thrifty young sprouts or seedlings of convenient size to graft while standing on the ground.

It should also be mentioned that the cions first set were mostly of the Japanese varieties, which are more dwarf in habit than the European chestnuts and do not grow as rapidly; therefore the average growth was rather small for early set cions.

In making the grafts some of the stocks were fully exposed to the sun. This was especially the case in the top of a large tree on the Station grounds. These stocks were seriously injured by "sun-scald," in some cases the whole branch dying back to the fork or body of the tree. It is advisable to leave a portion of the branches with enough foliage to afford a partial shade for a few weeks after the cions have been set. These should be mostly removed later, though some may be saved to graft the following season. Where the stock has been injured in this manner, the cion, if it grows at all, will probably never make a good union with the stock. With small stocks there is less surface to "callus" and heal over, hence a better union. Where the "whip" or "tongue" graft was employed, the union is smoother and looks better than with the other forms of grafting. The bark graft is probably the least satisfactory in this respect. Injury from winds may be prevented by tying the graft to a stake or some other support.

Experience of Others.— During the seasons of 1895 and 1896 the late Judge A. J. Coe had considerable grafting done upon some chestnut sprout-land in Meriden. Most of the sprouts of convenient size growing on eighteen acres were cleft-grafted. The cions were of two varieties originated by Luther Burbank of Santa Rosa, California, and belonged to the Japanese species (*C. Japonica*, Blume). These varieties have since been named "Coe" and "McFarland." A portion of the cions grew and a considerable number of these were afterward destroyed by fire. The writer made several visits to the orchard in 1897, and while no accurate census was taken, the proportion of grafts which lived and grew was probably not over thirty or thirty-five per cent.

Upon request, Mr. J. H. Hale has kindly furnished the following information regarding his experience in chestnut grafting:

"My experiments thus far have been mostly with such

varieties as Numbo and Paragon, which are of the European type and have not united as readily with our native stocks as the Japanese varieties we have tested.

"In the spring of '97 we put in about 600 grafts, beginning when the leaves were just sprouting on the stocks and finishing up a week or ten days later. The cions were perfectly dormant, having been kept so on ice. Fully 50 per cent. of them started to grow, but after attaining a growth of from four to six inches many of them died out, so that about 25 per cent. only lived and grew through the season. Of the Japanese variety, Reliance, about 75 per cent. made a good growth, and two of these cions are now fruiting freely this year. The stocks were mostly sprouts one to two inches in diameter; 'cleft,' 'saddle,' and 'tongue' grafting were practiced, 'cleft' grafting being the least successful.

"From our own experience here and observation in the Pennsylvania nut orchards, I am under the impression that tongue grafting on small stocks, not over a half inch in diameter, is likely to prove the most successful."

Mr. N. S. Platt was asked to give an account of his chestnut grafting. He kindly replied as follows:

"I have grafted only three kinds of chestnuts, the Paragon, Numbo, and Japanese. The young wood of the Paragon is coarse and angular, and cions are not so easily set in a cleft or bark graft as the Numbo, which has slender long-jointed wood. The latter variety I usually set by paring the graft on one side, leaving the pared portion long and slender and inserting it under the bark on one side of the stock.

"I used stocks about five-eighths to three-fourths inches in diameter where the cion was inserted. The graft, when set in this way, needs to be supported by tying to a stake from the time it has grown five or six inches till the end of the second year, to prevent it from blowing out; by that time the junction is usually strong.

Some Japanese grafts that I set in the top of a large tree, perhaps ten inches in diameter at the ground and four inches where grafted, grew for a year or two, but the junction was not good between the two, and all failed.

"I have usually splice-grafted the Paragon, using strips of waxed cloth and sometimes tying raffia over the cloth to bring all snugly together. As soon as the graft and stock enlarge, the raffia must be cut.

" For stocks I have gathered nuts myself and planted them ; have purchased and planted Paragon nuts, and have purchased one year sweet chestnut seedlings from Ohio. Have had all these in nursery rows and grafted them there. I put Paragon grafts in Paragon stocks, but also put Paragon and Numbo into both native and Ohio stocks. The union of graft with stock has been good with these two kinds in all the stocks used. The Paragon stocks were the more rapid growers, but the grafts lived no better and made no better union in Paragons than in natives. I set one hundred or more buds, but all failed. Grafting at the surface of the ground and root grafting were also failures. I employed Thomas Meehan & Sons to root graft and plant 1,000 stocks, I agreeing to take all that grew at a certain price. Mr. Meehan said to start with he did not know what could be done, but that he had an expert grafter and would like to try. At the end of the season he wrote me that he could find but two alive. The most of my grafting was done in the nursery rows, and to get trees for sale I preferred to graft three feet high and liked a stem one-fourth to three-fourths inches in diameter where grafted ; if the former size, I would use the splice graft ; if larger, the bark graft.

" Have sometimes had fifty per cent. of grafts start to grow, though often not more than thirty-three or twenty-five per cent. Have uniformly kept the cions in ice-houses lying flat on the ice, till new growth on the stocks is one or two inches long. For cions have used wood grown the previous season, also some a year older that contained good buds or spurs. Have found the after care during the first season almost as important as the grafting. The chestnut graft seems to need a full supply of sap till at least half the first season is passed, and it must have it or it will dry up in the midst of growth. See to this by keeping off robber shoots and by cutting off additional branches if there are any, even though in full leaf and growth.

" One of my first trees to graft was a wild tree about six inches in diameter, and in it I set cions in about eight stocks. Cions lived in about two-thirds of the stocks, but because I gave them no help all died in mid-summer. If I had cut off additional branches after growth had commenced, it would probably have saved them."

Conclusions.— Though the chestnut cannot be grafted as successfully as the apple or pear, about 50 per cent. of good

cions can be made to grow on proper stocks, if the work is done carefully and at the right time.

From a single season's experience (1898) it would appear that the best time for grafting chestnuts in this vicinity is from May 15th to June 15th. Early set cions made no growth until about May 20th. Growth on the stocks was then well advanced.

Do not remove all the foliage from around the graft at first, as it should be shaded for a time; otherwise the stock may be seriously injured or entirely killed by the sun. This injury is most likely to occur where the stocks are large. Many of the cions will need supporting, after growth begins, or they will be broken off by strong winds.

The best union results from "whip" or "tongue" grafting on small stocks.

Chestnut Literature. — If the reader desires further information on this subject, or to acquaint himself with the practices of commercial chestnut growing, he should consult the following publications:

The Nut Culturist, by A. S. Fuller, Orange Judd Company, N. Y., 1896.

Nut Culture, Division of Pomology, U. S. Department of Agriculture, Washington, D. C., 1896.

Nuts for Profit, by J. R. Parry, Parry, N. J., 1897.

The European and Japanese Chestnuts in the Eastern United States, by G. Harold Powell, Bulletin 42, Delaware Experiment Station, Newark, Del., 1898.

The author wishes to express his thanks to all who have aided his work, especially Messrs. Hale and Platt, who kindly supplied cions, and have contributed written accounts of their own experience in chestnut grafting.

ON THE AVAILABILITY TO GRASS OF NITROGEN IN FORM OF NITRATE OF SODA, COTTON- SEED MEAL, AND FINE HARD BONE.

BY E. H. JENKINS AND W. E. BRITTON.

These experiments were made in galvanized iron pots, wired on the upper edge, eight inches in diameter and twelve inches deep. The bottom is slightly concave, and in the center of the bottom is a hole with a collar three-fourths of an inch in diameter. The pot is supported on three iron legs, so that the lowest point of the collar is two and one-half inches above the platform on which the pot stands. These pots are like those used in experiments described in our earlier reports. The soil used was a very sandy loam from a field which, it was stated, had not been manured, fertilized, or cultivated for many years. Six determinations of nitrogen in samples taken from as many different parts of the heap of soil which had been screened, mixed and ready for use, gave the following percentages of nitrogen: 0.097, 0.100, 0.100, 0.099, 0.099, 0.098. Each pot contained twenty-nine pounds of soil and 13.022 grams of soil-nitrogen. Each pot had an area of very nearly 1-125,000 of an acre.

To the soil of each pot was added 9.5 grams of precipitated calcium carbonate (containing lime equal to one ton of slaked lime per acre), 1.8 grams of muriate of potash, equivalent to about 500 pounds per acre and 1.2 grams of precipitated phosphate of lime (containing phosphoric acid equal to that in about 1,000 pounds of acid phosphate per acre), besides the nitrogenous fertilizer as indicated in Table I.

The three nitrogenous matters used were nitrate of soda, 15.89 per cent. of nitrogen; cotton-seed meal, 7.40 per cent., and Rogers & Hubbard's pure raw knuckle bone, with 3.67 per cent. of nitrogen. These materials were all sifted to pass circular holes one-fiftieth inch in diameter.

The quantities supplied to the soil of the several pots are given in Table I. They were equivalent to the following quantities per acre:

Nitrate of Soda,	461 lbs	per acre, and	231 pounds	per acre.
Cotton-seed Meal,	991	"	496	"
Bone,	1,990	"	995	"

The quantities of fertilizer-nitrogen were alike, whether ap-

plied in form of nitrate, cotton-seed meal, or ground bone. In each pot were first placed fourteen pounds of the soil under experiment. With fifteen pounds of the soil were carefully mixed the fertilizers mentioned above, and this mixture was then filled into the pot, great pains being taken to pack the soil alike in all the pots of the series.

The pots, including a layer of gravel on the bottom, weighed five pounds each, and each received twenty-nine pounds of soil, equivalent to twenty-five pounds twelve ounces of water-free soil. The soil with 15.50 per cent. of water in it contained 70 per cent. of the moisture which it could hold if saturated, and with 11.60 per cent. of water in it the soil had 50 per cent. of what it could hold if saturated.

During the course of these experiments the moisture content of the soil was therefore allowed to sink to 11.6 per cent., and was then raised, by adding water, partly on the surface and partly at the bottom, to 15.50 per cent., as determined by frequent weighings.

Into each pot were transplanted three small sets, cut from a turf of common red-top. One dozen such sets as were used for this purpose contained 0.052 grams nitrogen. The pots were filled and planted Feb. 14th to Feb. 17th, and stood till June 10th in the greenhouse, having a temperature by day of about 60° F., and by night about 50° F. During the summer the pots were placed in the summer vegetation house, and brought into the greenhouse again in October.

The grass was cut whenever it reached a length of three or four inches, thus imitating the practice of grazing or lawnmowing, and all the clippings were carefully saved.

In early summer nitrogen was determined in the three clippings which had been already made, and again in the fall it was determined in the next three clippings. The first three clippings were made on March 31st, April 27th, and June 7th. The three later cuttings were made July 11th, Aug. 29th, and Oct. 1st. After the last cutting the growth was very slow, and the grass in every pot looked yellow, as if starving. A seventh cutting was, however, made on Jan. 7, 1899. The following table presents the results of this experiment :

TABLE I. ON THE AVAILABILITY TO GRASS OF NITROGEN IN NITRATE OF SODA, COTTON-SEED MEAL, AND FINE, HARD, RAW BONE.

EXPERIMENT OF 1898.

Station No.	Crop.	Nitrogenous Fertilizer.	Equivalent pounds per acre.	Nitrogen per pot.	1ST THREE CUTTINGS.		2D THREE CUTTINGS.		7TH CUTTING.		TOTAL CROP.	
					Air-dry Weight.	Grams Nitrogen.	Air-dry Weight.	Grams Nitrogen.	Air-dry Weight.	Grams Nitrogen.	Air-dry Weight.	Grams Nitrogen.
357	Grass	Nothing	0.00	0.00	10.6	.3795	14.9	.3248	1.7	.0356	27.2	.7399
358	"	"	0.00	0.00	11.4	.3887	16.3	.2950	1.4	.0282	29.1	.7119
359	"	"	0.00	0.00	12.0	.3972	17.4	.3149	1.8	.0343	31.2	.7464
360	"	"	0.00	0.00	10.9	.3793	13.4	.3015	1.8	.0367	26.1	.7175
361	"	Nitrate of Soda	461	.2665	17.4	.5933	18.7	.3441	1.9	.0351	38.0	.9725
362	"	"	461	.2665	18.4	.6072	16.9	.3262	1.4	.0308	36.7	.9642
363	"	"	231	.1333	12.8	.4646	16.1	.3349	1.7	.0340	30.6	.8335
364	"	"	231	.1333	13.3	.4748	15.0	.3315	1.1	.0245	29.4	.8303
365	"	Cot. Seed Meal	991	.2665	14.6	.5256	14.9	.3099	1.4	.0293	30.9	.8648
366	"	"	991	.2665	13.6	.5086	14.5	.3190	1.4	.0312	29.5	.8588
367	"	"	496	.1333	12.0	.4500	14.9	.3218	1.8	.0340	28.7	.8058
368	"	"	496	.1333	12.4	.4662	15.3	.3322	1.5	.0292	29.2	.8276
370	"	Ground Bone	1990	.2665	12.0	.4044	14.1	.3017	1.6	.0374	27.7	.7435
371	"	"	995	.1333	12.5	.3988	11.8	.2714	1.2	.0255	25.5	.6957

Examination of the table shows that *the soil alone*, without nitrogenous fertilizer, yielded in the year's cropping, seven cuttings, from 26.1 to 31.2 grams, an average of 28.4 grams of air-dry crop, and from .7119 to .7464 grams, — an average of .7289 grams — of crop-nitrogen. The first three cuttings took an average of 11.2 grams of air-dry matter, with .3862 grams of nitrogen; the next four cuttings took more air-dry matter, 17.2 grams, but less nitrogen, .3428 grams.

That is, the first three crops had 3.45 per cent. of nitrogen, the next four only 2.00 per cent.

An application of *nitrate of soda* at the rate of 460 pounds per acre, pots 361 and 362, yielded in the year's cropping 37.4 grams of air-dry crop and .9683 grams nitrogen. Deducting what was cropped from pots which had no nitrogenous fertilizer we have 9.0 grams of air-dry crop and .2394 grams nitrogen as the added yield from the .2665 grams of nitrate-nitrogen in the fertilizer. That is, 90.0 per cent. of the nitrate-nitrogen of the fertilizer was recovered in the crop, and the weight of crop was increased by 31.7 per cent.

The percentage of nitrogen in the first three cuttings was 3.35 and in the subsequent cuttings only 1.90 per cent.

Use of one-half the aforesaid amount of nitrate, or 231 pounds per acre; — pots 363 and 364, — gave a total yield of 30.0 grams of air-dry crop, containing .8321 grams of nitrogen. Deducting the crop from unfertilized soil there remains 1.6 grams of crop and .1032 grams of nitrogen as the increase from .1333 grams of nitrate-nitrogen in the fertilizer. That is, 77.4 per cent. of the nitrate-nitrogen of the fertilizer was recovered in the crop, — a smaller proportion than where a double quantity of nitrate was used.

Here, as before, the earlier crops weighed less but had more nitrogen than the later. The percentages of nitrogen were in the first three cuttings 3.59, and in the subsequent cuttings 2.14. These figures show that an addition to the soil of nitrogen in the form of nitrate of soda at the rate of 460 pounds per acre, increased the yield of grass nearly one-third over what the same soil yielded without nitrogenous fertilizers. About nine-tenths of the nitrogen put on in the fertilizer was taken off again in the first year's cropping. Only one-tenth was lost or left in the soil, roots, and stubble.

On the other hand, 231 pounds of nitrate of soda per acre increased the crop by about one-eighteenth (5.6 per cent.). A little less than eight-tenths of the nitrogen put on in the fertilizer (231 pounds of nitrate of soda per acre) was taken off again in the cropping. Two-tenths were lost or left in the soil.

An application of *cotton-seed meal*, at the rate of 900 pounds per acre, yielded 30.2 grams of air-dry crop and .8618 grams of nitrogen. Deducting what was cropped in pots which received no fertilizer-nitrogen, there is left 1.8 grams of air-dry crop and .1329 grams of crop-nitrogen to be attributed to the .2665 grams of fertilizer-nitrogen in the cotton-seed meal; 49.9 per cent. of the fertilizer-nitrogen has been recovered in this crop, while the crop had been increased by 6.3 per cent. The percentage of nitrogen in the first three cuttings was 3.67 and in the following cuttings 2.14 per cent.

The total yield of air-dry crop from the smaller application of cotton-seed meal, 496 pounds per acre, was 29.0 grams, with .8167 grams of nitrogen. Deducting as before the yield of the soil without nitrogenous fertilizers, we have 0.6 grams of crop and .0878 grams nitrogen as the added yield produced by the

.1333 grams of fertilizer-nitrogen; 65.9 per cent. of the fertilizer-nitrogen has been recovered in the crop. But the total yield has been increased by only 2.1 per cent.

As before, the first three cuttings contained most nitrogen, 3.75 per cent., while the later cuttings contained only 2.14 per cent.

The last two pots of the series, Nos. 370 and 371, received an application of *fine and hard raw bone*; one at the rate of 1,990 pounds per acre, the other at half that rate.

As noted above, the four pots to which no fertilizer-nitrogen was added, yielded an average of 28.4 grams of crop, containing .7289 grams of nitrogen. Neither pot to which bone was added yielded as large a crop as this,—the amounts are 27.7 and 25.5 grams, — one of them yielded slightly more nitrogen than those which received no fertilizer-nitrogen, viz., 0.7435 grams, and the other slightly less, viz., 0.6957 gram. So that the nitrogen of the bone has increased neither the air-dry crop nor the crop-nitrogen appreciably, while that of nitrate of soda and of cotton-seed meal had a marked effect.

It appears that the effect of the nitrogenous fertilizers on the amount of crop-nitrogen was shown chiefly in the first three clippings. In the second half of the year the yield of nitrogen was not very much larger on those pots which had received fertilizer-nitrogen than on those which had received none.

But, on the other hand, the gross yield of air-dry crop was considerably greater in the latter part of the year than in the early part immediately following the application of the nitrogenous matters.

These facts appear in the following statement:

TABLE II.—EXPERIMENTS OF 1898, GRASS.
CROPS AND CROP-NITROGEN HARVESTED IN THE TWO HALF-YEARS.

FERTILIZER NITROGEN.		NITROGEN HARVESTED.		AIR-DRY CROP HARVESTED.	
In Form of	Amount. Pounds per Acre.	In First Half- Year. Grams.	In Second Half-Year. Grams.	In First Half- Year.	In Second Half-Year.
None.	....	.3862	.3428	11.2	17.2
Nitrate of Soda,	461	.6002	.3681	17.9	19.5
"	231	.4697	.3625	13.1	16.9
Cotton-seed Meal,	991	.5171	.3497	14.1	16.1
"	496	.4581	.3586	12.2	16.8
Raw Bone,	1,990	.4044	.3391	12.0	15.7
"	995	.3988	.2969	12.5	13.0

Immediately after the last cutting the pots were top-dressed with the same forms of nitrogen which they originally received, and the experiment is continued. The surface of the soil is now in most cases nearly covered with a sod which has grown from the original three sets.

These tests illustrate certain facts regarding plant-food which may be briefly noted:

Here are pots each containing twenty-nine pounds of soil in which there is more than thirteen grams of soil-nitrogen; enough, at a low estimate, to produce thirteen maximum crops, *if it were available*.

Yet this soil cannot produce a single large crop, and in nearly an entire year, under very favorable conditions, has not yielded to the crop more than one-seventeenth of the nitrogen it contains. This fact well illustrates the inert character of the nitrogen in this soil. Again, an addition to this soil of .2665 grams of nitrogen in a quickly available form, increased the air-dry crop by nearly one-third. Yet this quantity of nitrogen is but one-fiftieth of the nitrogen originally in the soil; an amount almost too small to determine with accuracy by chemical means.

That is, an amount of fertilizer-nitrogen in the soil, which can barely be detected in the soil by chemical analysis, may yet be enough to make the difference between a good crop and a poor one.

As the applications of fertilizers were planned to correspond to the amounts which might be applied to equal areas of grass-land, it is worth noting how the crops correspond. If we multiply the crops by 125,000 and divide by 454 to reduce grams to pounds, it appears that from the pots which received an abundance of phosphoric acid and potash, *but no nitrogen*, we harvested at the rate of 7,351 pounds per acre of air-dry crop (much dryer than ordinary hay at harvest), or 3.6 tons. Where nitrate was put on at the rate of 460 pounds per acre we harvested in one case 9,939, in the other 9,719 pounds of hay,—9,879 pounds on the average, or about 4.9 tons per acre. Of course the chance for error is large in calculating yields per acre from such small areas, but the results indicate at least that our crops were larger than could be expected from similar areas in the field.

Strict comparison cannot be made between these pot cul-

tures and meadow-land because on one hand the trials went on without break from Feb. 17th to Jan. 7th, and under conditions of temperature, illumination, and water supply that were, on the whole, more favorable than could happen out-of-doors. On the other hand, the sets at first covered but a small portion of the surface of the soil, and they have not only yielded the crops whose amounts have been stated, but they have also nearly or wholly covered the soil with turf and penetrated it extensively with their roots. Accordingly the results of this first year's growth are but partially represented in the harvested crops. In all the pots a considerable amount of soil-nitrogen has already become root and turf-nitrogen, and no doubt much of the fertilizer-nitrogen not recovered in the harvests has been appropriated by the plants and will benefit future crops. The grass is now established, and the second year of its growth may be expected to show a better effect from the fertilizers, unless it suffers for want of the resting period which grass under natural conditions experiences during our winter season.

In these tests where nitrate of soda was used at the rate of 461 pounds per acre (73 pounds of nitrogen), 90 per cent. of the fertilizer-nitrogen was recovered in the crop. From an equal amount of nitrogen in form of cotton-seed meal, 50 per cent. of the fertilizer-nitrogen was recovered, while from an equal amount of nitrogen in fine hard raw bone not more than 5.0 per cent. was recovered.

When half the quantities of nitrogen named above were used the following percentages of the fertilizer-nitrogen were recovered in the crops: From nitrate of soda, 77 per cent., from cotton-seed meal, 66 per cent., from bone, none.

A small part of the nitrate-nitrogen, about half of the cotton-seed meal nitrogen, and nearly all of the bone-nitrogen has not been recovered in the crops. This is either in the roots of the grass which are still in the soil or it has been removed from the soil by microbe action and has passed off in gaseous form; or it is in the soil, perhaps, in available or, more likely, in rather inert forms.

As regards the inefficiency of the bone as a fertilizer it should be remembered that in these trials the hardest, most compact, and, therefore, least alterable variety of bone was purposely chosen. It is not improbable that the grass would

have done better with a considerably greater supply of water, and it is certain that a softer and more porous bone would have yielded nitrogen much more rapidly and abundantly. The result shows, however, that hard bone dust requires either to be partially rotted or steamed or else treated with sulphuric acid before applying to sandy or light-loamy soils if profitable, *i. e.*, quick returns are to be expected from its use as a fertilizer.

EXPERIMENTS IN CURING AND IN FERMENTING TOBACCO.

BY E. H. JENKINS.

These experiments are in continuation of those begun in 1897, and described in the Twenty-first Report of this Station, p. 223. The cured crop of 1897 was destroyed by fire before it had been fully examined as to its quality.

In 1898 a new barn was built on the land of the Connecticut Tobacco Experiment Company, in Poquonock, where our experiments have been hitherto made.

This barn is 60 feet long, 32 feet wide, 16 feet high to the eave plates, having vertical ventilators of the usual kind, hinged just below the eaves and opening down to the sills. It also has a ventilator two feet by three in each gable end, just below the peak, with a shutter which can be closed or opened from the ground by cords. Below this ventilator there are six narrow ventilators, hinged from the top. On each end of the barn are two large doors, built in the usual way, and on one side is a small door for entering the barn during the cure. The sides and ends of the barn are battened on the inside. The lower tier of poles for hanging tobacco rests on slip-girths, so that the lath of tobacco on this tier hang crosswise of the building, like those above. The barn is built on stone and brick piers. The space between the sills and the surface of the ground is boarded up. In the center of the barn is a brick chimney — with a flue thirteen by eight inches in the clear, — which goes through the roof just to one side of the ridge pole. Except that the barn has a chimney and is made as tight as possible and battened, it is not at all unlike other barns in the neighborhood. Two stoves of heavy sheet iron, two feet eight inches from front to back, with a breadth and height of two feet four inches, each stove having a cast-iron door with draft, are used for heating the barn. One stove on each side of the barn, midway from end to end of it, is set in an excavation outside the building, the bottom of the stove being six feet below the level of the sill. Around the sides and rear end of the stove is a brick wall, having an air space of five inches closed in the front side. This wall is five inches higher than the top of the stove, iron bars are laid across it, which support a sheet-iron cover, and this, in turn, is covered with earth. On the front, near the

bottom, are openings which supply air to this air-space, which surrounds the stove except on the front and bottom.

This whole structure is three feet below the sill at its nearest point. From the stove, and through the air-space, a smoke pipe seven inches in diameter passes under the sill and into the barn straight to the chimney, having a rise of about five feet in going the distance of seventeen or eighteen feet. From the air-space, two hot-air flues, seven inches in diameter, pass into the barn, which is built with its ridge running east and west. Within the building and four feet from the south side of the barn one of these flues turns at a right angle and runs east to within four feet of the east end of the barn, thence north to within four feet of the center line of the building, and thence west till it joins the smoke pipe near the chimney. The other hot-air flue on the south side runs in a similar way to the west end of the barn and back again to the smoke pipe. The arrangement on the north side of the barn is similar. By brick supports these hot-air pipes are given a pretty uniform pitch, rising all the way from where they enter the barn to where they enter the chimney.

The hot-air flues are also connected where they enter the building, with the smoke pipe, and by the use of dampers one can send all the smoke through the smoke pipe direct, and the hot air from the hot-air chamber, through the flues; or the products of combustion can be sent through the hot-air pipes.

It is best to start the fires with direct draft to the chimney, but when the chimney has got well warmed the draft is sufficient to draw the smoke through the hot-air flues without smoking the building at all.

The pipes are numbered, and, when not in use, taken up, boards being laid down where the pipe runs below the surface of the ground and covered over with earth. After the barn is filled with the harvested tobacco the pipes can be laid in an hour's time.

In front of each stove the earth is sloped up to the general surface of the field, and boards are so placed as to prevent caving. A lean-to affords protection to the one who tends the fires. The building was inspected by the insurance companies and insured on a premium of one and one-half per cent.

The land, a little less than two acres, was dressed in the spring of 1898 with 2,000 pounds of castor pomace, plowed in early, 3,000 pounds of cotton-seed meal, and 1,600 pounds of

cotton-hull ashes applied broadcast, near planting time, and 1,000 pounds of Swift-Sure Superphosphate, put on as a "starter" in the rows just before setting time.

The crop was set about the tenth of May. The harvest generally in the state was a large one. This particular piece, however, suffered from drought, and nearly stopped growing for two weeks, when it had reached about two-thirds of its full height. Then, with abundant rain, it finished its growth, but the crop was a light one, — about 1,250 pounds per acre, — and the quality was rather poor.

It is worth noting that the dry weather immediately followed the last cultivation with the Prout hoe. If showers had followed this cultivation, the crop would have been a normal one. Or if the cultivation had been omitted, or done with a very shallow cultivator, the following dry weather would have done much less harm. The Prout hoe, when the plants were well developed, pruned the roots so much that *in a dry time* they could not supply what water the plants needed. After the plants are three feet high or more it is probably safe to till very shallow. Deep cultivation at that time, *if followed by abundant rain*, will do no harm, but if followed by dry weather may set back the growing crop. On July 29th the crop was put in the barn.

On the west half of the barn the lath were hung six inches apart, from top to bottom of the barn. On the east half they were seven inches apart on the two lower tiers and six inches on the upper ones.

On July 30th, at 4 P. M., all doors and ventilators were closed, except the two in the gable ends, and fire was started in the furnaces. The heat was well distributed by the flues, the temperature inside was brought to 80-87, while without it ranged from 69 to 74, with fog or rain.

It had been assumed that sufficient air would enter the building below through cracks between the boards and under the sills. A careful examination of the tobacco, however, on August 5th showed that, particularly near the outside on the sides and ends, the circulation was insufficient, the leaf was not drying sufficiently, and in one or two places water had condensed on the leaves. All the ventilators and doors were immediately opened, the weather being fair, and the whole was brought into good condition again. The boards below the sill

were loosened and partly or altogether left open during the rest of the curing time, as it was clear that this was necessary in order to get the necessary circulation.

The heating was then continued at evening and in unfavorable weather, but during bright, dry days it was discontinued and the barn opened, as is usually done by growers.

The leaf had all come to color by August 20th, and it only remained to dry out the "stems," or mid-ribs.

The cure was perfectly successful, with the exception of the small portion damaged as above described.

A further trial is planned in 1899, with slightly modified arrangements. Ventilators will be hung under the sills on all sides of the barn to admit air, and the ventilating capacity at the top of the barn will be somewhat increased.

Few realize the amount of evaporation which must go on in the curing barn between harvest time and the time when the leaf is pole-cured and stripped.

A single lath of tobacco, six plants, was weighed at harvest time, and every week thereafter till the tobacco was cured. From these weights is calculated the weights *per acre* of tobacco. The quantity weighed was of necessity very small, but as the results agree well with the known yield of cured leaf per acre they represent approximately the actual loss of the crop during curing.

At harvest (July 29th) there were put in the barn 24,160 pounds of tobacco plants, weight of lath not included, from one acre of tobacco; 8,000 plants.

On August	5th	this weighed	18,495	pounds.
" "	11th	" "	13,996	"
" "	18th	" "	10,329	"
" "	21st	" "	9,497	"
" September	23d	" "	5,332	"

On the last date there were 1,499 pounds of cured leaves and 3,833 pounds of stripped stalks.

That is, twelve tons of tobacco were put into the barn, and during the cure, lasting eight weeks, more than nine tons of water, with perhaps small quantities of other matters, passed off through the ventilators as vapor. This is equivalent to 2,200 gallons, or nearly fifty barrels, holding forty-five gallons each.

Regarding the chemical changes which go on during the cure, we know very little. But it is generally agreed that to get the best results water must evaporate from the leaves not too rapidly, but continuously, without check and without chilling, which may condense drops on the leaf and thus discolor it and furnish a point for the attacks of molds or bacteria, inducing "burn" or "rot."

It is generally believed, too, that repeated drying and dampening gradually darkens the leaves, and thus makes them of less value for the present demand of the market, which requires light-colored wrappers.

Our aim is to use natural conditions when they are favorable, opening the barn on all warm, dry days, and to maintain these favorable conditions within the barn at night and in bad curing weather by means of artificial heat, never raising the temperature within beyond what it would be in the best of curing weather, but protecting the leaf from chilling, from the deposit of water on it, and from the alternate dampening and drying noted above.

The artificial heat must be so used as to maintain a current of warm air through the *whole mass* of the tobacco, and not through one part of it more than through another.

Further experiment is needed, but the results obtained this year make us confident that the use of artificial heat in some form will make the curing of tobacco less hazardous and give a better average quality of leaf.

THE FERMENTATION OF TOBACCO IN BULK.

BY E. H. JENKINS.

The nature of the fermentations which take place in the curing, fermenting, and aging of leaf tobacco has been recently studied by Dr. Loew of the United States Department of Agriculture, whose conclusions are given in a report (No. 59), "On the Curing and Fermentation of Cigar Leaf Tobacco," issued by the United States Department of Agriculture.

Dr. Loew finds that, — contrary to the statements of Suchsland and others, — the fermentation of tobacco is not caused by bacteria, nor is the aroma of tobacco due to the action of specific bacteria.

Fermenting tobacco, when it has the proper content of moisture, from 18 to 25 per cent., is germicidal in its action, and few if any microbes are found on freshly fermented leaves.

The principal changes that take place in the curing and fermentation are due to the action of soluble ferments or enzymes found in the plant while growing, and perhaps while wilting after the harvest. The enzymes are chemical bodies, — not living organisms, like bacteria or molds, — which, under proper conditions, cause extensive chemical changes in bodies associated with them. A familiar example is the enzyme of malt, called diastase. Malt, by reason of this diastase, can convert many times its weight of starch into a sugar.

In the fermentation of tobacco leaf the main changes are caused by two oxidizing enzymes alone, by the agency of which the oxygen of the air is made to unite with various compounds contained in the leaf. The development of color and aroma is due principally to the action of these oxidizing enzymes.

Dr. Loew finds that one of these is no longer able to act when it is heated to 149°-151° Fahr., while the other is rendered inactive only by a much higher temperature, 188°-190° Fahr.

These observations of Dr. Loew, which it is to be hoped will be supplemented by further studies, are of the greatest interest and importance to growers and packers of leaf tobacco. It has long been known that tobacco, if packed too closely, will not ferment properly; which is readily understood if fermentation is an oxidation process, requiring the presence of

air, which too close packing almost entirely excludes. It is a question whether, under our usual methods of packing in cases, sufficient air is always present for fermentation, until by drying in the cases the leaves have shrunk somewhat, and thus admitted air.

If these enzymes or ferments are the controlling factors in fermentation, it is of importance to study their occurrence and the things which favor their presence, and especially their activity in the cured leaf.

In the Northern States wrapper leaf tobacco is, almost universally, fermented in cases. The sorted leaves, tied by their butts, with an inferior leaf, into "hands," containing from thirteen to twenty or more leaves, are carefully packed in cases, with the aid of a press, each case containing about 300 pounds. This is done during the winter and early spring, and these cases are piled three or four high in warehouses, usually unheated, where they lie over one summer. They are turned over once or twice during the time, and in the early fall samples are drawn and the cases are sold to manufacturers or dealers by the sample. It is believed that little fermentation goes on till early summer. Tobacco fermented or "sweated" in this way cannot, therefore, be sold to manufacturers till a year after harvesting.

It cannot be examined during the fermentation or "sweat" to see if it is taking damage of any kind, and the success of the process is always in doubt until it is done and the cases are stripped in the fall.

In the Southern States, in Cuba and in Sumatra, leaf tobacco is always fermented in piles or "bulks," which are constantly examined and frequently turned over and rebuilt. The skillful operator can see at once if the operation is not going as it should, and can frequently correct the trouble.

Formerly, when leaf having a dark color was in demand, Connecticut packers sometimes "forced-sweated" the leaf, which had been previously fermented in the usual way. To do this, the leaf was made as damp as was thought safe, packed again into cases, and placed in a room where a high temperature — 100°-120° Fahr. — was maintained. In five or six weeks the process was complete.

During the last two years, owing to the scarcity of fermented wrapper leaf in the market, packers have hastened the

fermentation of new-crop leaf by placing the cases, packed as usual, in rooms heated to 90°, 100°, or even to 130° Fahr. — depending on the packer's idea of what might be most favorable. Some have kept the air of these rooms quite moist, the relative humidity being 80 per cent.

In this way the leaf could be put on the market in six or eight weeks from the time it was packed. It is too early to decide whether as fine a quality of leaf is secured in this way as by the old-fashioned and slower method.

In order to test the method of fermenting Connecticut wrapper leaf by the process used at the South, i. e., in a heap instead of in a case, the crop described in the previous paper, page 299, was fermented in the following way:

A basement room was used for the purpose, the temperature of which was about 80° Fahr. day and night, because of a main steam pipe which passes through it to another building. By means of live steam from a pet cock on this pipe, the temperature could be raised to 90° Fahr. or more, and the air made very moist. By means of maximum and minimum thermometers and a hygrometer the heat and moisture could be watched, and with the aid of steam and occasional sprinkling of floor and walls kept quite uniform.

On November 1st a bulk was made as follows: On the cement floor were laid damp tobacco stems covered with trash tobacco, well pressed down, making a layer five inches deep. At each end were stanchions to hold the bulk, and matched planed pine boards were put against them, next the tobacco. About 930 pounds of tobacco, 314 pounds of top leaves, and 616 pounds of seconds (bottom, "sand" leaves), all tied in hands, were piled up between the stanchions, just as they are laid in a case, the butts to the side of the bulk.

The whole made a pile about five feet high. The top leaves were judged to be in good condition for fermenting; the seconds were too dry, but we preferred not to apply moisture till we had some experience with the process.

Near the bottom, center, and top of this bulk, as it was built, were laid electrical thermometers, devised by Whitney and Evans and kindly loaned to us for the purpose by Professor Whitney, chief of the Division of Soils, United States Department of Agriculture. By this means, with a special telephone instrument, the temperature can be taken at any time without

disturbing the bulk at all. The top and sides of the bulk were covered with stems and trash tobacco, held in place by a few scantling.

During the fermentation the temperature of the room averaged 82° , and after a few days' experience in regulating it, ranged from 77° to 85° . The relative humidity averaged 80 per cent., ranging from 75 to 91.

The temperature of the top of the bulk rose to 100° Fahr. in nine days, or at the rate of four degrees in twenty-four hours. The temperature of the center rose to 102° Fahr. in the same time, at the rate of four and one-half degrees in twenty-four hours. The temperature at the bottom in the same time rose to 79° Fahr., or less than two degrees per day.

Very soon after the tobacco has become warm by reason of the fermentation, it develops a very characteristic sweetish odor, reminding one of that of beeswax, or perhaps of plug tobacco. There is absolutely no smell of ammonia at this stage of the process, but as the temperature of the bulk goes down after the active fermentation is over the sweetish smell gradually diminishes, the tobacco within the bulk develops some ammonia, and the leaf begins to acquire the odor of fermented tobacco.

The bulk was now made over, putting what was on top before at the bottom of the new bulk. The bottom of the first bulk was at the top of the second, while the center of the first bulk was at the center of the second. The hands were shaken out to prevent the leaves from becoming matted together.

The temperature of the top of the new bulk rose to 102° Fahr. in five and one-half days, or at the rate of four degrees in twenty-four hours.

The temperature of the center, which fell to 92° in making over the bulk, rose to 98° Fahr. in four and one-half days, little more than one degree daily, while the temperature of the bottom (which had been the top of the first bulk) fell in making over the bulk to 86° Fahr., and rose to 89° in six and one-half days.

From this time, about November 18th, the temperature slowly and steadily declined till December 9th, when the temperature readings were discontinued, although the temperature and humidity of the room were kept constant. On this

date the temperature of the top and middle of the bulk was 93° Fahr., and of the bottom 85° Fahr.

This bulk stood till January 4th, when the top leaves were separated, cased, and sent to a dealer for sale. They were still quite damp, easily handled, and had lost in the fermentation only 4.4 per cent. of their weight. We are informed by the dealer that they have since lost weight considerably by drying out in the case, as was to be expected. The leaf was pronounced by him well sweated; it had lost the sweet smell so characteristic of fermenting tobacco and looked and smelled like old leaf. It had nothing peculiar about it different from leaf fermented in the usual way.

We were advised to dampen the seconds and try fermenting them further, which we did, applying *very* little moisture, and making the bulk on January 4th. The temperature rose scarcely at all, and on January 14th the leaves were made quite moist by blowing and a new bulk built. The temperature rose from 79° Fahr. to 100° Fahr. in four and one-half days, little more than four degrees per day, and then sank continuously.

On February 6th the tobacco had entirely lost its sweet smell and was giving off ammonia. It was then cased and sent away for sale.

We next undertook the fermentation of the wrappers, in the way above described. They were in rather "high case," fully as damp as was deemed safe, and contained 27.5 per cent. of water.

The bulk contained 1,305 pounds, and was built January 13, 1899. The top and sides of this bulk were covered with woolen blankets, two-inch plank being laid on top of the bulk, and the whole pressed down by the weight of several persons. The temperature of the room averaged about 85° and the relative humidity 85 per cent. during the first two weeks, and from then on the temperature averaged 80° Fahr., and relative humidity 70 to 75 per cent. The temperature of the tobacco in the bulk was as follows:

	Jan. 13.	Jan. 18.	Increase.	Increase per Day.
Top of bulk.	71°	91°	22°	4 1/2°
Center of bulk,	65°	91°	26°	5°
Bottom of bulk,	68°	82°	14°	3°

On the 18th the bulk was built over, putting at the bottom

of the new bulk what had been at the top of the first one, and shaking out the leaves which were inclined to mat together.

The temperature record of this bulk was as follows:

	Jan. 18.	Jan. 24	Increase.	Increase per Day.
Top of bulk,	84°	98°	14°	4°
Center of bulk,	86°	99°	13°	4°
Bottom of bulk,	89°	91°	2°	..

On the 27th mold was found on a few hands next the blanket, on the top of the bulk where the blanket had been wet, and fearing there was more beneath, the bulk was again made over. No more mold was found.

The temperature changes from this time on were as follows:

	Jan. 27.	Feb. 6.	Increase.	Increase per Day.
Top of bulk,	82°	95°	13°	1.3°
Center of bulk,	83°	93°	10°	1.0°
Bottom of bulk,	84°	81°	-3°	...

From February 6th the temperature steadily and slowly declined throughout the bulk. On February 27th the bottom temperature was 78°, the center 84°, and the top 89°. The air of the fermenting room was then allowed to cool gradually to 70°, and became dryer as the tobacco was pronounced well sweated.

The tobacco remained in this bulk until March 27th, when it was cased and shipped. At this time it had nearly lost the characteristic sweet smell of fermenting tobacco, and had a slight smell of ammonia. During the fermentation it lost about 8 per cent. of its weight.

The leaf was examined by a dealer in leaf tobacco, and by a cigar manufacturer, both of whom found it "well-sweated," not distinguishable from leaf fermented by the usual methods, and having an odor of old tobacco, quite different from the leaf which had been fermented at a high temperature in cases.

These observations indicate that high temperatures, 120°-130°, are not at all necessary for the rapid fermentation of tobacco, and that our Connecticut leaf will ferment perfectly well in piles instead of cases, and when the process is complete, will be moist enough to be readily handled and cased down.

ANALYSES OF FEEDS.

The following feeds have been examined by Messrs. Winton, Ogden, and Mitchell, at the request of those named below, who have sent the samples to the Station:

10847. Blatchford's Calf Meal, made by E. W. Blatchford & Co., Chicago. Sent for microscopic examination by the Maine Agricultural Station. Mr. Winton found it to contain a large proportion of linseed meal; bean products (hulls and starch identified), wheat (wheat starch and hairs identified), and fenugreek were also found.

Dr. Woods states that the sample has the following composition:

Water,	7.70
Ash,	5.46
Protein,	25.63
Fiber,	5.28
Nitrogen-free Extract,	50.37
Fat,	5.56
	<hr/>
	100.00

Of two samples of "wheat-flour" sent by Dr. B. W. Kilgore, State chemist of Mississippi, one was found by Mr. Winton to consist wholly of wheat, the other contained a large quantity of corn starch.

10231. Chicago Gluten Feed. Stock of B. B. Broadbent, Hamden Plains. Sampled and sent by John B. Phelps, Hamden.

10823. Gluten Feed, sent by Charles M. Jarvis, East Berlin.

10229. The H. O. Co.'s Dairy Feed. Stock of R. G. Davis, New Haven. Sampled and sent by E. A. Bradley, Hamden.

10230. Quaker Oat Feed. Stock of Abner Hendee, New Haven. Sampled and sent by E. A. Bradley, Hamden.

10155. Chaff. Sent by A. N. Farnham, New Haven.

ANALYSES.

	Chicago Gluten Feed. 10,231.	Gluten Feed. 10,823.	H. O. Dairy Feed. 10,229.	Quaker Oat Feed. 10,230.	Chaff. 10,155.
Water,	6.81	10.45	6.14	5.74	7.41
Ash, . . . . .	.95	2.81	4.57	5.40	10.02
Protein,	23.88	14.81	20.38	11.75	7.75
Fiber,	7.26	7.94	12.29	11.44	24.95
Nitrogen-free Extract, .	56.11	53.96	52.00	61.64	47.52
Fat (Ether Extract), .	4.99	10.03	4.62	4.03	2.35
	<hr/> 100.00	<hr/> 100.00	<hr/> 100.00	<hr/> 100.00	<hr/> 100.00

WATER-FREE.

Ash,	1.02	3.14	4.87	5.73	10.82
Protein,	25.63	16.55	21.71	12.47	8.37
Fiber,	7.79	8.87	13.09	12.14	26.95
Nitrogen-free Extract, .	60.21	60.24	55.41	65.39	51.32
Fat (Ether Extract), .	5.35	11.20	4.92	4.27	2.54
	<hr/> 100.00	<hr/> 100.00	<hr/> 100.00	<hr/> 100.00	<hr/> 100.00

A large number of "Feeds" are now on the market, being residues or by-products from some manufacture. Thus the gluten feeds are by-products of starch and glucose manufacture; H. O. Feed and Quaker Oat Feed come from factories where certain "breakfast foods" are prepared. The first question with the feeder should be, are they concentrated feeds, containing decidedly more nitrogenous matter, protein, than belongs to corn-meal? If not, it seldom if ever pays to buy them. The feeder should raise his own ensilage, corn fodder and corn-meal. The use of boughten feeds is to supplement home-grown products by increasing the *proportion* of digestible protein in the ration. This cannot be done with feeds which, like corn meal, contain no more than ten or eleven per cent. of protein. If the prepared feeds do not contain more protein than wheat bran, sixteen to eighteen per cent., it is still a question whether it will not pay better to buy a standard article, like wheat bran, which has been thoroughly proved in dairy practice, than to try these new preparations.

TESTS OF THE VITALITY OF VEGETABLE SEEDS.

BY E. H. JENKINS.

Since November, 1897, three hundred and thirty-three samples of seed have been examined as to their vitality. This work has been done chiefly in the interest of seed growers and seed dealers in this State, and has been executed for the most part by Mr. V. L. Churchill.

The methods of testing adopted by the Association of American Agricultural Colleges and Experiment Stations have been closely followed, and the standard germinating chambers have been used.

Table I presents the average, maximum and minimum vitality of all the seeds tested at the Station by the newly adopted methods. The age of the seeds given in the table is that reported by the seedsmen or growers who sent the samples. The samples were in all cases drawn by the persons sending them. Since the samples were sent by the seedsmen for their own information, and it was understood that the results of the tests were not to be published as representing the character of their goods, there was no motive for any misrepresentation as to the age of the seed. The samples for the most part undoubtedly represented cleaned seed as prepared for market.

TABLE I.—GERMINATION TESTS OF VEGETABLE SEEDS

	Age of Seed in years, when tested.	Number of Samples.	Average Percentage by number of Seed Sprouting	Maximum.	Minimum.
Beans,	0-1	7	86.5	100.0	56.7
	1-2	15	91.1	100.0	72.0
	2-3	8	87.0	100.0	59.0
	3-4	15	92.3	99.0	83.0
Beets,	0-1	18	162.0	211.0	65.5
	1-2	13	175.7	230.0	120.5
	2-3	4	146.6	192.0	73.5
Brussels Sprouts,	3-4	1	36.0	....	....
Cabbage,	0-1	23	80.9	94.0	44.0
	1-2	9	78.4	96.5	38.8
	2-3	3	71.5	88.0	43.0
	3-4	3	74.7	91.5	55.8
	4-5	2	64.9	85.8	44.0
	6-7	1	63.8	....	....
Carrots,	0-1	19	59.5	90.8	35.0
	1-2	15	48.7	91.3	14.5
	2-3	5	43.6	54.2	31.0
	0-1	1	84.5	....	....
Cauliflower,	1-2	4	51.1	88.3	27.5
	3-4	1	77.3	....	....
	0-1	17	68.0	83.5	38.3
Celery,	1-2	7	42.9	63.8	25.3
	2-3	9	55.5	79.3	9.8
	3-4	5	55.4	63.5	27.3
	0-1	3	93.3	99.0	83.0
Corn, Sweet,	1-2	13	74.5	98.0	37.5
	0-1	3	61.5	91.3	35.5
Cress,	0-1	10	86.3	99.0	57.0
Cucumber,	1-2	8	85.9	95.5	67.5
	3-4	4	76.4	90.0	64.5
	4-5	1	79.0	....	....
	0-1	1	70.3	....	....
Dandelion,	0-1	1	40.0	....	..
Egg Plant, . . . . .	...	3	85.5	92.0	78.3
Kale, . . . . .	...	2	90.1	93.5	86.8
Kohl Rabi,	0-1	3	84.5	86.0	83.5
Leek,	1-2	3	76.5	79.3	74.0
	2-3	1	35.5	....	....
	0-1	25	90.4	100.0	18.0
Lettuce,	1-2	23	84.3	100.0	23.5
	2-3	11	74.3	98.8	23.8
	5-6	1	10.3	....	...
	0-1	2	190.0	203.0	177.0
Mangel Wurzel,	1-2	3	153.0	176.0	138.0
	2-3	3	131.0	181.0	101.0
	0-1	8	75.4	100.0	28.0
Musk Melon,	1-2	10	67.9	96.5	29.0
	3-4	5	45.4	81.0	19.5

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TABLE I. — CONTINUED.

	Age of Seed in years when tested.	Number of Samples.	Average Percentage by number of Seed Sprouting.	Maximum.	Minimum.
Onion, Connecticut grown, .	0-1	155	72.4	97.5	36.8
	1-2	31	55.5	91.5	0.8
	2-3	20	18.1	68.3	0.5
	3-4	1	59.5	....	....
California grown, .	0-1	33	91.3	97.5	77.3
	1-2	9	86.5	98.0	58.5
	2-3	3	85.9	91.5	87.5
	3-4	1	10.0	....	....
Parsley,	0-1	1	73.3	....	....
	1-2	4	37.1	72.0	7.8
Parsnip,	0-1	4	52.5	63.5	34.3
	1-2	4	15.6	42.8	2.5
	2-3	1	30.3	....	....
Peas,	3-4	2	98.5	99.0	98.0
Pepper,	0-1	4	76.6	89.5	61.0
	1-2	1	29.3	....	....
Pumpkin,	0-1	5	70.7	95.0	40.0
Radish,	0-1	18	87.7	99.8	72.0
	1-2	15	67.4	87.0	31.0
	2-3	7	38.0	55.5	22.5
	3-4	10	31.6	69.5	5.3
Salsify,	0-1	1	80.5	....	....
Spinach,	0-1	14	80.7	89.7	59.5
	1-2	1	72.0	....	....
Squash,	0-1	12	84.9	100.0	68.8
	1-2	2	86.5	98.0	75.0
	3-4	5	44.4	82.0	1.0
Tomato,	0-1	8	82.8	97.0	76.0
	1-2	6	86.7	93.5	77.5
	2-3	1	65.5	....	....
	3-4	3	70.2	96.2	43.5
Turnip,	0-1	2	92.9	96.8	89.0
	1-2	4	95.8	97.8	90.5
	3-4	3	76.5	94.5	49.8
Water Melon,	0-1	7	82.7	100.0	56.3
	1-2	6	39.6	77.0	0.0
	2-3	7	43.5	81.0	0.0
	3-4	1	42.0	....	....
	5-6	1	69.5	....	....

The "percentage" of beet seed and mangel wurzel sprouting, as given in the table, is nearer 200 than 100. To test the vitality of beet seed one hundred "seeds" are put in the germinating apparatus and all the sprouts are counted. As each beet "seed" is a fruit which may contain from two to six separate seeds, it is evident that the possible number of sprouts may be 600. To count the actual number of seeds in the one hundred fruits examined, which would make a true percentage statement of sprouting power possible, would be extremely laborious; but the form of statement here followed is sufficiently intelligible and is justified by usage.

Vitality of Onion Seed as affected by the Age of the Seed.

Since November 1, 1896, the Station has examined 110 samples of onion seed of the crops of 1896, 1897, and 1898. To these, in the following table, are added the results of tests made in previous years, by the methods recommended by the Association of Agricultural Colleges and Experiment Stations. In the samples examined, the percentage by number of seed which sprouted was as follows:

TABLE II.—VITALITY OF ONION SEED.

	CONNECTICUT GROWN.		CALIFORNIA GROWN.	
	No. of Samples.	Per cent. Sprouted.	No. of Samples.	Per cent. Sprouted.
Seed stated to be less than 1 year old.	155	72.3	33	91.3
Seed stated to be between 1 and 2 years old.	31	55.6	9	86.6
Seed stated to be between 2 and 3 years old.	20	18.1	3	85.9
Seed stated to be between 3 and 4 years old.	1	59.5	1	10.0

While the number of samples examined of California-grown seed is not large enough to make a close comparison, it is quite evident that a larger percentage of the California seed germinates than of the Connecticut seed.

Table II also shows that onion seed more than one year old, as a rule, has much less sprouting capacity than new seed, although in Table V are numerous cases of onion seed more than a year old which sprout as well as most new seed.

Whether the plants produced from old seed are as vigorous and productive as those from fresh seed is quite another question, on which laboratory germination tests can give no light.

Comparison of the Vitality of Crops of Connecticut-grown Onion Seed in the years 1894-1898.

The average sprouting capacity of Connecticut-grown onion seed, as determined for a number of years at this Station, has been as follows :

TABLE III.—VITALITY OF CROPS OF ONION SEED.

	No. of Samples Tested.	Average Percentage Sprouted.
In 1880	14	87.0
1894	25	82.9
1895	13	85.5
1896	44	72.4
1897	39	77.9
1898	68	69.3

The sprouting capacity of onion seed in 1898 has been unusually low, for reasons which are not evident.

The Sprouting Capacity of Different Varieties.

The average sprouting capacity of four varieties, of which a considerable number of samples has been tested, is as follows (only those samples are here included which were alleged to be less than one year old at the time of testing) :

TABLE IV.—SPROUTING CAPACITY OF DIFFERENT VARIETIES OF ONION SEED.

Variety.	No. of Samples Tested	Average Percentage of Sprouting Seed.
Yellow Globe, . .	77	73.9
Red Globe, . . .	62	76.6
White Globe, . .	39	75.4
White Portugal, .	22	68.3
Wethersfield Red, .	2	72.4

Four of the varieties are essentially alike in sprouting capacity, but the White Portugal appears to be inferior to them in this regard.

In 1898 the seed of the yellow globe variety had a lower percentage vitality than either the red or white globe varieties.

TABLE V.—GERMINATION TESTS MADE IN 1898 OF ONION SEED RAISED IN CONNECTICUT.

Variety.	Station No.	Age of Seed in years, when tested.	Percentages of Seed, by Number.			No. of Days within which one-half of the Sprouting Seed Germinated.
			Sprouted in 14 days.	Remained Hard.	Decayed.	
Yellow Globe, Crop of 1895, .	1686	3-4	59.5	29.2	11.3	4
Crop of 1897, .	1685	1-2	81.8	3.2	15.0	3
Crop of 1898, .	1684	0-1	87.2	0.5	12.3	3
	1695	0-1	64.3	17.5	18.2	3
	1728	0-1	48.3	7.0	44.7	3
	1730	0-1	43.5	8.5	48.0	3
	1731	0-1	55.0	11.8	33.2	3
	1733	0-1	53.8	11.0	35.2	3
	1734	0-1	49.3	11.0	40.7	3
	1748	0-1	59.3	7.0	33.7	3
	1749	0-1	72.0	6.0	22.0	3
	1750	0-1	75.3	6.2	20.5	3
	1760	0-1	74.0	7.2	18.8	4
	1898	0-1	62.5	4.0	33.5	4
	1899	0-1	46.3	9.0	44.7	4
	1900	0-1	59.8	5.2	35.0	4
	1942	0-1	61.8	3.5	34.7	3
	1943	0-1	53.0	8.8	38.2	3
	1950	0-1	49.0	6.2	44.8	3
	1951	0-1	52.0	10.5	37.5	3
	1954	0-1	53.0	6.5	40.5	3
	1955	0-1	45.8	9.0	45.2	3
	1968	0-1	66.8	7.8	25.4	4
	1973	0-1	81.0	2.0	17.0	3
Red Globe, Crop of 1898,	1683	0-1	82.7	6.5	10.8	3
	1718	0-1	80.7	3.5	15.8	3
	1719	0-1	65.5	6.0	28.5	3
	1720	0-1	91.0	5.0	4.0	3
	1721	0-1	78.8	5.0	16.2	3
	1722	0-1	72.3	5.0	22.7	3
	1723	0-1	70.5	7.0	22.5	3
	1724	0-1	76.0	6.0	18.0	3
	1725	0-1	87.0	5.2	7.8	3
	1726	0-1	61.8	13.5	24.7	3
	1727	0-1	62.8	12.5	24.7	3
	1729	0-1	63.8	11.0	25.2	4
	1735	0-1	46.3	9.5	45.2	3
	1737	0-1	83.3	5.0	11.7	3
	1751	0-1	54.0	5.5	40.5	3
	1752	0-1	74.0	7.3	18.7	3
	1753	0-1	63.0	6.8	30.2	3
	1754	0-1	80.3	4.5	15.2	3
	1901	0-1	67.3	10.0	22.7	4
	1902	0-1	79.5	2.2	18.3	4
	1903	0-1	83.5	3.5	13.0	3
	1944	0-1	77.3	3.8	18.9	3
	1945	0-1	79.8	4.8	15.4	3
	1946	0-1	74.8	4.2	21.0	3

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TABLE V.—CONTINUED

Variety.	Station No.	Age of Seed in years, when tested.	Percentages of Seed, by Number.			No. of Days within which one-half of the Sprouting Seed Germinated.	
			Sprouted in 14 days.	Remained Hard.	Decayed		
Red Globe, Crop of 1898,	1947	0-1	78.0	3.2	18.8	3	
	1948	0-1	67.3	10.0	22.7	3	
	1949	0-1	74.8	3.0	22.2	3	
	1953	0-1	82.0	2.2	15.8	3	
	1970	0-1	92.0	2.8	5.2	4	
	1972	0-1	64.5	8.2	27.3	3	
Wethersfield Red, Crop of 1897.	1688	1-2	84.0	1.0	15.0	2	
Crop of 1898,	1761	0-1	89.8	2.8	7.4	4	
Early Red Flat, Crop of 1896,	1687	2-3	33.3	38.5	28.2	3	
Crop of 1898,	1758	0-1	97.5	0.0	2.5	3	
White Globe, Crop of 1897,	1689	1-2	38.8	39.5	21.7	3	
Crop of 1898,	1682	0-1	77.0	4.8	18.2	3	
	1732	0-1	66.8	5.0	28.2	3	
	1736	0-1	66.5	6.0	27.5	3	
	1738	0-1	56.5	11.0	33.5	3	
	1739	0-1	67.0	6.7	26.3	3	
	1740	0-1	61.3	8.0	30.7	3	
	1755	0-1	79.8	8.8	21.4	3	
	1897	0-1	73.3	6.5	20.2	4	
	1944	0-1	72.3	6.8	20.9	3	
	1952	0-1	68.8	5.5	25.7	3	
	1969	0-1	88.5	5.2	6.3	4	
	1971	0-1	67.3	4.5	28.2	3	
White Portugal, Crop of 1896,	1661	2-3	18.2	31.0	50.8	5	
	1662	2-3	8.2	70.0	21.8	6	
	1663	2-3	0.5	48.5	51.0	10	
	1664	2-3	7.7	73.0	19.3	5	
	1665	2-3	11.0	53.0	36.0	5	
	1666	2-3	10.3	65.5	24.2	5	
	1667	2-3	2.2	58.2	39.6	4	
	1668	2-3	12.0	51.5	36.5	5	
	1669	2-3	38.5	33.0	28.5	4	
	1670	2-3	65.0	17.5	17.5	4	
	1671	2-3	3.8	81.5	14.7	6	
	1672	2-3	13.0	83.0	4.0	6	
	1673	2-3	6.8	78.2	15.0	4	
	1675	2-3	2.5	84.5	13.0	4	
	1680	2-3	6.7	74.8	18.5	5	
	Crop of 1898,	1681	0-1	77.8	6.0	6.2	3
		1896	0-1	79.0	5.1	15.9	4
Prize Taker, Crop of 1896,	1690	2-3	68.3	12.5	19.2	3	

EGG ALBUMIN.

BY THOMAS B. OSBORNE.

Crystallized egg albumin was first observed by F. Hofmeister, whose directions for preparing it are briefly as follows (*Zeitschr. f. physiol chemie*, 14, 165): Fresh egg white is whipped to a froth, and after standing twenty-four hours is mixed with an equal volume of saturated solution of neutral ammonium sulphate and filtered to separate globulin. The filtrate is collected in wide, shallow dishes and allowed to evaporate at ordinary temperature for several days, or until no further precipitate of albumin appears. The substance thus deposited is re-crystallized several times from half-saturated ammonium sulphate solution, by evaporation, as before, until it is obtained in clear, acicular crystals unmixed with spheroids.

Hopkins has recently shown (*Jour. Physiology*, 23, 131) that the crystallization of egg albumin is greatly facilitated by the addition of acetic acid to the half-saturated ammonium sulphate solution. I have found that crystallization is thus promoted, because crystallized egg albumin is a compound of the protein substance with acid.

As Hopkins observes, when egg white is first mixed with half-saturated ammonium sulphate solution an alkaline reaction towards litmus can be detected and a decided odor of free ammonia develops. I find that after this solution has stood for some hours, all evidence of free ammonia disappears, and the solution is then perfectly neutral to litmus and continues neutral during the gradual separation of the albumin. The deposited substance, however, whether in the form of spheroids or of crystals, when filtered out and dissolved in water, reacts distinctly acid with litmus, as well as with phenolphthalein.

In order to obtain well-crystallized albumin by Hofmeister's method it is necessary to precipitate it several times, evidently because, during the first precipitations an insufficient amount of acid is formed or set free to produce the crystalline compound. It is well known that neutral aqueous solutions of ammonium salts lose ammonia and become acid when evaporated or exposed to the air.

If acetic acid be added, as Hopkins directs, all the albumin that separates is completely crystallized by a single precipitation, and that, too, without concentrating by evaporation.

I have found that if, instead of acetic acid, a molecularly equivalent quantity of hydrochloric acid be added, the separation takes place even more quickly and, so far as my experience goes, within a short time is more complete than with acetic acid during the same time.

Thus, I prepared from two equal portions of perfectly fresh egg-white a quantity of crystallized albumin by aid of each of these acids, with the following results :

One portion of 1,500 cc. of egg-white was mixed, as Hopkins directs, with an equal volume of saturated ammonium sulphate solution and filtered over night. Next morning saturated ammonium sulphate solution was added to the clear filtrate to incipient precipitation, and thereupon 46.5 cc. of 10 per cent. acetic acid were added, drop by drop, with constant shaking, and the mixture was set aside in a cold room.

The other 1,500 cc. of egg-white was similarly treated, but instead of acetic acid, 67.5 cc. of 4 per cent. hydrochloric acid, well mixed with 232.5 cc. of half-saturated ammonium sulphate solution were added very gradually, with constant agitation and formation of some permanent precipitate.

After three hours a very large crystalline precipitate had separated in the portion with hydrochloric acid. This precipitate was then filtered out, but the portion with acetic acid was allowed to stand for twenty-four hours, as the deposit appeared to be much less than that in the hydrochloric solution.

These two precipitates were each twice recrystallized, freed as completely as possible from mother liquor by pressing out with filter paper, dissolved in water, and the solutions dialyzed for ten days, until wholly freed from sulphate, when they were filtered clear and evaporated at about 50°. The residue left by the acetic acid solution (A 1) weighed 29 grams; that from the hydrochloric acid (H 1) 59 grams.

The filtrates from the several crystallizations of these two preparations yielded a second crop of crystallized albumin; that from the acetic acid solution (A 2) weighing 43 grams; that from the hydrochloric solution (H 2) 7.9 grams. Similarly, from the mother liquors from these preparations, two other entirely crystalline products were obtained, weighing respectively (A 3) 8 grams, and (H 3) 4.9 grams. From the finally remaining acetic acid solutions another preparation separated, consisting wholly of spheroids (A 4), which weighed 9.1 grams.

There were thus secured from 1,500 cc. of egg-white, by adding acetic acid, 80 grams of well crystallized albumin, and from 1,500 cc., with hydrochloric acid, 71.8 grams, or 5.3 and 4.9 grams respectively per 100 cc. of egg-white.

The crystallized albumin, like all other preparations of native proteids which I have as yet examined, is a compound of a protein substance with an acid. In order to neutralize to litmus and to phenolphthalein the solutions of one gram of each of these preparations of crystallized albumin, it was necessary to add the following quantities of decinormal potassium hydroxide solution:

	A ₁ .	A ₂ .	A ₃ .	A ₄ .	H ₁ .	H ₂ .	H ₃ .
To phenolphthalein,	2.05 cc.	2.30 cc.	2.30 cc.	2.35 cc.	2.05 cc.	2.25 cc.	2.20 cc.
To litmus,	1.30 cc.	1.60 cc.	1.65 cc.	1.55 cc.	1.30 cc.	1.60 cc.	1.50 cc.
Difference,	0.75 cc.	0.70 cc.	0.65 cc.	0.80 cc.	0.75 cc.	0.65 cc.	0.70 cc.

If the molecular weight of the protein substance is assumed to be about 15,000,* one gram would react with 0.67 cc. of a decinormal solution, a quantity nearly equal to the difference in acidity shown by these two indicators. Three molecules of acid reacting with one of albumin would be equal to 2 cc. of decinormal solution per gram of albumin, a quantity in very close agreement with that found for the two large fractions A₁ and H₁), and which differs but little from that required to neutralize one gram of the other fractions.

When crystallized albumin, dissolved in water, was neutralized with decinormal potassium hydroxide, the solution evaporated to dryness and the proteid matter burned off, an ash was left containing potassium carbonate nearly equivalent to the acid of the albumin originally neutralized. From this it would appear that the acid is mostly, if not wholly, organic.

As yet I have not been able to discover what acid or acids are united to the albumin. Neutralization of the substance suspended in 50 per cent. alcohol resulted in the formation of a gummy mass difficult to filter and wash, and from which none of the products of neutralization could be separated. Neutralizing a solution of ten grams of crystallized albumin and dialysis in distilled water failed to give enough salts in the diffusate to shed light on the nature of the acid. Neutralization with

* Sabanejeff (Chem. Centrbl., (1891), 10.) found the molecular weight of purified egg albumin by determining the lowering of the freezing-point to be 15,000.

baryta of a solution of two grams of the albumin gave a very slight precipitate, which after standing some days was filtered out, washed, and ignited, but only four milligrams of mineral matter were obtained.

The preparations showed no excess of sulphur over that usually found in coagulated and thoroughly washed albumin prepared without the use of sulphuric acid or sulphates. Determination of total phosphorus showed A 1 and H 1 to contain 0.37 and 0.40 per cent. phosphorus pentoxide respectively. These preparations contained 0.87 and 0.69 per cent. of ash which was almost wholly insoluble in water and appeared to consist chiefly of calcium phosphate. The total phosphorus in these preparations was equivalent to 0.59 and 0.64 per cent. of tricalcium phosphate respectively.

Towards lacmoid these preparations reacted alkaline, about 1 cc. of decinormal acid being required to neutralize the solution of one gram, and 3 cc. to give an acid reaction. When one gram was treated with decinormal hydrochloric acid no evidence of free acid was shown with tropaeolin, until 8 or 9 cc. were added.

When pure water solutions containing 2.5 per cent. of my albumin preparations were heated, they all became turbid at 58° - 59° , and a minute quantity of flocks separated at 59° - 60° . On gradually raising the temperature the coagulum slowly increased, until at 70° much of the dissolved albumin had coagulated. The solutions heated for some time at 74° and filtered still contained a little proteid, which even on heating at 99° did not separate until some salt was added.

No break in this gradual coagulation of the albumin was detected, the solutions when filtered after partial coagulation yielding a coagulum on again heating up to the temperature to which they had been previously raised. When solutions of pure 10 per cent. sodium chloride brine containing 2.5 per cent of any of these preparations except A 3, H 3, and A 4, were slowly heated, turbidity developed at 56° - 59° , and flocks at 56° - 60° .

Only a trace of coagulum was obtained, however, below 64° , and the solutions filtered therefrom remained perfectly clear until heated to nearly or quite 70° , when the albumin began to coagulate. It was, however, found necessary to heat the solution to nearly 84° before most of the proteid separated.

The three preparations, A 3, H 3, and A 4, behaved as just

described, except that each yielded a relatively considerable coagulum below 64° . These preparations, it is to be noted, are final fractions obtained in small quantity, and it is probable that the coagulum obtained at 60° - 64° is due to the presence of a different substance from that constituting the chief part of the other fractions. This is the more probable as A 3 and A 4 also showed a difference in specific rotation as well as in composition.

The degree of acidity has much influence on the coagulation of albumin. Exact neutralization to phenolphthalein, as might be expected, entirely prevents coagulation, even on boiling. When crystallized albumin is so far neutralized that its acidity is equal to 1.2 cc. of decinormal acid per gram of albumin, a solution containing 2.5 per cent. of the proteid becomes slightly opalescent on heating to 72° , and remains otherwise unchanged, even after heating for a long time in a boiling water bath. If, however, the acidity is but 0.1 cc. greater, or equal to 1.3 cc. per gram of albumin, the solution becomes turbid at 70° and very opaque after heating in the water bath at 99° . The difference between the two solutions is marked, and it is evident that the additional 0.1 cc. causes a change in the condition of the albumin. An acidity of 1.33 cc. per gram is almost exactly equal to two molecules of acid per molecule of albumin, assuming the latter to have a molecular weight of 15000.

From this it would seem to be necessary to add three molecules of acid to one of albumin, in order to form the coagulable substance.

The specific rotation of these preparations was approximately determined by means of a Schmidt & Haensch polariscope, using a 200 millimeter tube. The readings on the sugar scale were converted into degrees of circular polarization by multiplying by 0.346. The formula used in calculating the results is:

$$(\alpha)_D = \frac{a \times 100}{p \times d \times l}$$

where a = observed rotation.

p = per cent of albumin in the solution.

d = density of the solution.

l = length of tube in decimeters.

The results obtained were as follows:

Preparation.	Per Cent. of Dissolved Albumin.	Solvent.	Rotation.	Average.
A1,	{ 5.861	Water	—29° 48' }	—29° 17'
	{ 6.670	"	—28° 46' }	
A2,	3.422	"	.....	—29° 23'
A3,	3.273	"	.....	—33° 3'
A4,	3.404	"	.....	—41° 45'
	{ 3.425	10 p. ct. NaCl.	—29° 0' }	
H1,	{ 3.237	Water	—28° 33' }	—28° 35'
	{ 6.478	"	—28° 1' }	
H2,	1.699	"	.....	—28° 14'
H3,	3.207	"	.....	—39° 31'

As the results obtained on A 1, A 2, H 1, and H 2 agree closely, and as these preparations represent very different proportions of the total albumin of the egg-white, it seems probable that we have in these fractions but one proteid substance.

Bondzynski and Zoja, working with solutions containing ammonium sulphate, obtained similar but somewhat lower figures for the specific rotation of their least soluble fractions, namely, 25° 8' and 26° 2', duplicate determinations on the same fraction. Three other fractions gave them 29° 16', 34° 18', and 42° 54', figures agreeing fairly with those obtained by me for my more soluble fractions. They determined the albumin in the polarized solution by coagulation, a process not so exact as that employed by me, which consisted simply in evaporating the pure water solution, drying to constant weight at 110°, and deducting ash. A slight error in determining the dissolved albumin causes a considerable error in the specific rotation.

The effect of acid and alkali on the rotation of crystallized albumin solutions is shown by the following results, obtained by dissolving one gram of A 2 in 25 cc. of water and treating with the given quantities of acid or of alkali:

1 gram A. 2 + nothing	—29° 17'
+ 0.8 cc. N/10 HCl	—29° 5'
+ 8.0 cc. "	—33° 46'
+ 1.4 cc. N/10 KOH	—28° 45'
+ 2.7 cc. "	—30° 20'
+ 4.2 cc. "	—32° 30'

It is to be noted that by 8 cc. of the acid and by 4.2 cc. of the alkali a rotation was produced about 10 per cent. higher than

with the smaller quantities of acid or alkali. This increase may well be due to a local over-reaction taking place on mixing the acid and alkali with the proteid solution, it having been demonstrated that large proportions of acids and alkalies yield products of high specific rotation.

Panormoff (Ref. in Chem. Centrbl., 1898, II., 358 and 487) has studied the specific rotation of fractionally precipitated crystallized egg albumin, and concludes that there are two albumins present in egg-white, one with a specific rotation of -23.6° , and the other -36.2° . The albumin with the lower rotation he obtains from the so-called egg globulin precipitated by adding to egg-white an equal volume of saturated ammonium sulphate solution. This he succeeded in crystallizing, and, so prepared, finds it to have the properties and composition of albumin. He considers, therefore, the egg globulin to be a compound of egg albumin with some unknown substance.

As egg-white is alkaline to litmus, and ammonia is set free on adding to it a saturated solution of ammonium sulphate, it is not surprising that a product should be produced of different solubility from that of the acid albumins which we have been considering.

Panormoff converted his crystallized albumin into a chloride by dialysis against 0.2 per cent. hydrochloric acid. He analyzed the product obtained, and it is interesting to note that, if calculated free from hydrochloric acid, the figures for the albumin are in exceedingly close agreement with the average of the best analyses of albumin. Furthermore, the proportion of hydrochloric acid in Panormoff's compound is the same as I have found albumin capable of fixing by using tropæolin as an indicator. I found that one gram of albumin unites with 8 cc. of decinormal acid, or 0.0292 gram hydrochloric acid, to form a compound showing no free acid with tropæolin, while Panormoff's chloride contained 2.92 per cent., or exactly the same quantity.

In regard to the composition of egg albumin, confusion has recently been caused by Hofmeister, who states (*Ztschr. physiol. Chem.*, 24, 166) that he has found in repeatedly recrystallized egg albumin 1.01 and 1.18 per cent. of sulphur, and that Dr. F. N. Schulz, in his laboratory, has obtained 1.24 and 1.27 per cent.. He consequently calls in question the purity of the samples of crystallized albumin analyzed by Bondzynski and Zoja. As Hofmeister's figures for carbon are higher, and

for nitrogen lower, than those of Bondzynski and Zoja, and of other investigators who have analyzed *amorphous* egg albumin, the whole question of the composition of this substance is again thrown into confusion.

Having at hand a sample of egg albumin which had been three times recrystallized in the manner described by Hofmeister as necessary for its purification, and obtained in the same proportion from egg-white as stated by him to be the usual yield after thorough purification, and which had been coagulated with alcohol and thoroughly washed until all ammonium sulphate was removed, I analyzed it, dried at 110° , with the result given under No. 1.

Analyses of the seven fractionally crystallized preparations (A 1, 2, 3, and 4, and H 1, 2, and 3) were made after drying them to constant weight at 110° , and are as follows:

	No. 1.	H 1.	H 2.	H 3.
Carbon,	52.18	52.85	52.33	51.72
Hydrogen,	6.91	6.92	6.90	6.90
Nitrogen,	15.67	15.66	15.77	15.26
Sulphur,	1.70	1.57	1.64	1.96
Oxygen,	23.54	23.00	23.36	24.06
	100.00	100.00	100.00	100.00
Ash,	0.56	0.69	0.67	0.59
Total Phosphorus pentoxide,	0.40	0.40	0.21	trace
	A 1.	A 2.	A 3.	A 4.
Carbon,	52.60	52.61	52.33	51.44
Hydrogen,	7.02	6.94	6.93	6.88
Nitrogen,	15.54	15.76	15.40	15.20
Sulphur,	1.61	1.61	1.78	1.91
Oxygen,	23.23	23.08	23.56	24.57
	100.00	100.00	100.00	100.00
Ash,	0.87	0.65	0.67	0.40
Total Phosphorus pentoxide,	0.37	0.28	trace	trace

There can no longer be question that the amount of sulphur in albumin is greater than that stated by Hofmeister. My sulphur determinations were made with extreme care, fusing more than a gram of the substance over an alcohol lamp with pure sodium hydroxide and peroxide in a nickel crucible, dissolving the fusion* in hydrochloric acid, nearly neutralizing

* A black substance containing sulphur (nickel sulphide) often appears which must be completely dissolved, otherwise too low results will be obtained.

the excess of acid, and precipitating with barium chloride from a boiling solution of at least 800 cc. volume. Blank determinations showed no trace of sulphur in the re-agents, and also that none was absorbed during fusion over the alcohol lamp.

These results agree with those obtained by Bondzynski and Zoja, though the difference in composition between their extreme fractions was not quite so great as found for my preparations.

The composition, rotation, heat-coagulation points, and reactions of the crystallized egg albumin obtained by aid of hydrochloric or acetic acid show this to be the same substance as that which has in the past been regarded as egg albumin.

The results of Bondzynski and Zoja, of Panormoff, and my own, make it plain that there are two protein substances in egg-white, which are commonly obtained admixed when egg albumin is prepared by the usual processes. Further work on large quantities of egg-white is already in progress here, with a view to the complete separation of these bodies.

Moerner (*Zeitschr. f. physiol. Chem.*, 18, 525) has described ovomucoid as identical with Neumeister's pseudopeptone (*Zeitschr. Biologie*, 9, 369), and states that it constitutes about one-eighth of the organic matter of egg-white. Since ovomucoid is described as largely, though not wholly, precipitated by two-thirds saturation of its solution with ammonium sulphate, it ought, if present as such in egg-white, to be found among the more soluble fractions thrown down by successive additions of ammonium sulphate.

It is intended to direct especial attention to the isolation of this substance and to determine, if possible, in how far it may be admixed with the albumins.

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